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User's Guide to Fish Habitat: Descriptions that Represent Natural Conditions in the Salmon River Basin, Idaho

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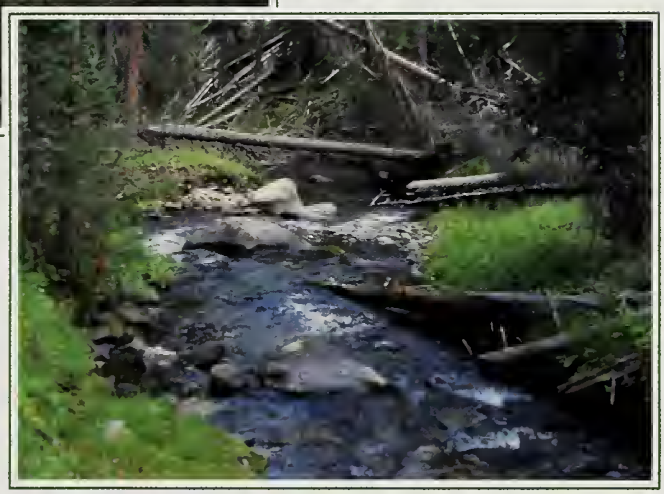

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Research Summary

This user's guide and reference document describes the physical features of stream channels that represent natural conditions for fish habitat within the Salmon River Basin in Idaho. The term "natural condition" refers to the structure and pattern of streams that have not been substantially influenced by human disturbances. Data were collected at four landscape scales—watershed, channel reach type, habitat type, and mesohabitat (habitat type attribute). This hierarchical outline facilitates multiscale data analysis; the scales are synonymous with analysis areas for watershed (cumulative effects) and site (individual project) assessments. Data were collected from streams within the Salmon River Basin (summertime base-flow inventory) using the Forest Service's R1/R4 [Northern Region/Intermountain Region] Fish and Fish Habitat Standard Inventory Procedures. Summary statistics were calculated for bank stability, bank undercut, width-to-depth ratio, width-to-maximum-depth ratio, surface fines, water temperature, large woody debris

Front cover: These two photos taken in the Salmon River Basin, Idaho, show creeks with moderately confined channel reaches and wooded cover class. Top photo—McCalla Creek (index 44, reach 3). Bottom photo—Germania Creek (index 24, reach 9).

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frequency, and pool frequency. Large woody debris and pool frequency are summarized by stream size classes.

The statistical summaries for the above habitat attributes can be grouped in different ways to create meaningful comparisons. For this document, the data were grouped by all stream reaches combined, by channel reach types distinguished by gradient and confinement, and by dominant geology and channel reach type. Relative frequency distributions and cumulative relative frequency distributions were graphed to display all the statistics of variation for the selected habitat variables grouped as above. Statistical summaries for additional habitat type attributes collected by the R1/R4 Fish and Fish Habitat Standard Inventory Procedures and for more refined groupings (such as by drainage area, dominant vegetation class) can be generated using the natural condition electronic data base (dBaseIV). Examples displaying some optional approaches for stratifying summary statistics are provided.

The intended uses of this natural condition data base are (1) to assist National Forest fishery biologists and resource managers in determining the current and potential condition of fish habitat for multiscale analysis areas and (2) to describe the desired resource condition for a reach, watershed, or basin that can be achieved through management objectives.

Acknowledgments

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Contents

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Introduction

A goal common to several Forest Service, U.S. Department of Agriculture, policies and guidelines (FEMAT 1993; USDA FS 1991; USDA FS and USDI BLM 1995) is to describe the current conditions of an analysis area compared to its potential. The Pacific Northwest, Northern, and Intermountain Regions of the Forest Service, for example, were directed to develop descriptors or variables that represent "desired future conditions" (desired future conditions elements and subelements, table 1) for anadromous fish habitat and riparian areas within National Forest administered lands of the Columbia River Basin (USDA FS 1991). The Regions responded by appointing tri-regional coordination teams, conducting biologist workshops, and initiating field inventories and research. More recently, the Pacific Southwest and Alaskan Regions and the Bureau of Land Management were added to this task of developing desired future conditions objectives and variables under the umbrella of PACFISH (strategy for maintaining and restoring anadromous fish habitat and watersheds within Forest Service and Bureau of Land Management, U.S. Department of the Interior, administered lands, FEMAT 1993). Although the objectives have stayed the same, the desired future conditions elements are often referred to as PACFISH variables or features that indicate good habitat for anadromous fish (table 2) (FEMAT 1993; USDA FS and USDI BLM 1995).

This document describes the Intermountain Region's approach to this assignment and provides the fish biologist or resource manager a description of stream characteristics that represent natural conditions in the absence of major human disturbances.

Biologists from the Northern and Intermountain Regions and scientists from the Intermountain Research Station completed a study of the scientific and agency literature. They identified fish habitat attributes considered both ecologically significant to fish and affected by land management disturbances. These habitat attributes are bank stability, bank undercut, temperature, width-to-depth and width-to-maximum-depth ratios, surface fines, large woody debris frequency, and pool frequency (table 3). Habitat variables other than these were collected for future analyses. Protocols for identifying and measuring prescribed fish habitat attributes, a set of standard stream inventory procedures (Overton and others, in preparation),

Table 1—Desired future condition elements and potential subelements identified in the Columbia River Anadromous Fish Policy and Implementation Guide (USFS 1991). This table is not intended to be a comprehensive list of all important subelements. It may be necessary to identify additional subelements to adequately describe habitat features limiting fish production capability in a specific National Forest watershed.

Sediment/substrate
Surface fines
Cobble embeddedness
Fines by depth
Suspended sediment/turbidity
Macroinvertebrate community composition
Water quality/quantity
Temperature
Dissolved oxygen
Instream flow (consistent with Forest objectives)
Miscellaneous pollutants
Channel morphology
Inchannel large, woody material
Pool frequency/quality
Habitat composition (riffle/pool/glide)
Bank stability/characteristics
Floodplain/riparian vegetation
Potential input of large woody material
Ground cover (sedge/shrub/tree)
Vegetation community composition and condition

Table 2—Quantitative summary of features used to describe good habitat for western anadromous streams. This table is taken from "PACFISH: A Strategy for Conservation and Restoration of Pacific Salmon and Anadromous Trout on Western Lands Managed by the Forest Service and Bureau of Land Management." Summary is based on the evaluation of over 100 different streams.

Habitat feature	Desirable characteristics								
Pool frequency	Varies by channel width, see below:								
Wetted width in feet:	10	20	25	50	75	100	125	150	200
Number pools per mile:	96	56	47	26	23	18	14	12	9
Water temperature	Compliance with state water quality standards, or maximum <68 °F								
Large woody debris (forested systems)	Coastal California, Oregon, Washington, and Alaska. >80 pieces per mile; >24 inch diameter; >50 foot length								
	East of Cascade Crest in Oregon, Washington, Idaho. >20 pieces per mile; >12 inch diameter; >35 foot length								
Bank stability[1] (non-forested systems)	>80 percent stable								
Lower bank angle[1] (non-forested systems)	>75 percent of banks with <90 degree angle (undercut)								
Width/depth ratio	≤10								

[1]Not included as part of R6 core set of numeric values.

Table 3—Field collected and calculated variables for each habitat type using the R1/R4 Fish and Fish Habitat Standard Inventory Procedures (Overton and others, in preparation).

Field measured variables	**Calculated variables**
Habitat type dimensions	Habitat type dimensions
Thalweg length	Area
Width	Volume
Depth	
Maximum depth	Pool dimensions
Pool tail depth	Residual maximum depth
	Residual pool volume
Pocket pool	Width/depth ratio
Frequency	
Mean depth	Large woody debris
	Size classes
Surface fines	Volume
Pool tails	Frequency (No./100 m)
Low gradient riffles	
Substrate composition	
Large woody debris	
Numbers	
Dimensions	
Bank condition	
Bank stability	

and a data base management system were developed to facilitate summary and analysis of the data.

Field surveys of streams in the Salmon River drainage in Idaho (see fig. 1 for general locations, fig. 2 for Hydrographic Unit Code Identification, and appendix A for a photographic record) were conducted from 1991 through 1993 using the Forest Service's R1/R4 [Northern Region/Intermountain Region] Fish and Fish Habitat Standard Inventory Procedures (Overton and others, in preparation). We assume that these streams have channel dimensions, form, and patterns of systems influenced only by natural disturbance regimes (such as fire, flood, drought) and that the frequency distributions for the selected habitat type variables approximate the spatial and temporal variability for the Salmon River Basin.

The collected data were stratified using a hierarchical scheme that simplifies analysis at multiple landscape scales. The data summaries are intended to assist biologists and land managers in meeting the following objectives: (1) to determine the current condition of an analysis area (reach or watershed); (2) to determine the natural or potential condition of an analysis area; and (3) to develop desired future conditions objectives for fish habitat within multiple-scale analysis areas.

The natural condition data base will help show what percent bank stability, percent bank undercut, water temperature, wetted mean width-to-depth, wetted mean width-to-maximum-depth (scour pools only), and percent surface fines (less than 6 mm in diameter, scour pool tails and low gradient riffles) look like within unconfined, low-gradient (less than 1.5 percent) channel reaches (response, "C" type); moderately confined, moderate-gradient (1.5 to 4.0 percent) channel reaches (transport, "B" type); and, confined, steep-gradient

Figure 1—General location of streams that were surveyed to develop the "natural condition" data base.

Figure 2—Hydrologic Unit Code (HUC) boundaries and identification numbers for watersheds within the Salmon River Basin.

(more than 4 percent) channel reaches (source, "A" type) for the four dominant geologies in the Salmon River Basin in Idaho.

Frequency distributions are used to display statistical variations for the selected habitat variables grouped as above. Even more refined groupings can be generated to compare the natural condition data base to managed reaches or watersheds by matching specific reaches with similar drainage areas, elevation, climate, and habitat types.

We believe the data summaries in combination with other information from an analysis area (such as disturbance history, location, frequency, duration, and magnitude) and other analytical tools (such as spatial display and query of attributes and disturbance in a geographic information system) will help identify the relationship between disturbance and fish habitat, predict the effects and risks of prescribed management actions, determine the design and location of restoration efforts, and extrapolate results from sampled areas to unsampled areas.

Landscape Scales

The R1/R4 [Northern Region/Intermountain Region] Fish and Fish Habitat Standard Inventory Procedures prescribe data collection at four landscape scales—watershed, channel reach type, habitat type, and mesohabitat (habitat type attributes). These scales are similar to the organizational schemes described by Frissell and others (1986) and Minshall (1993) for aquatic riverine systems. The scales follow the context of watershed analysis (USDA 1994a), which plays a major role in the aquatic conservation strategy for fitting analysis protection and restoration plans to specific landscapes (FEMAT 1993). This hierarchical organization permits multiscale data analysis; the scales are synonymous with analysis areas from watershed (cumulative effects) and site (individual project) assessments. Higher levels of organization in a multi-scaled system provide the template from which lower levels have evolved (Allen and Starr 1982; Bourgeron and Jensen 1993; O'Neill and others 1986). Each scale is nested in the next higher scale, thus constraining the structure and function of the lower scale.

Each scale has a temporal aspect. For example, watersheds generally change on a geological timeframe where lower scales are progressively more dynamic, having less resistance to change through the influences of natural and human-induced disturbances (see Bourgeron and Jensen 1993; Frissell and others 1986; Minshall 1993). Higher (river basin) or lower (microhabitat) scales can also be linked to this hierarchical scheme for assessments of population viability (Frissell and others 1993; Rieman and McIntyre 1993) or stream bioenergetics (Minshall 1993), respectively.

The data structure follows the ecological and analysis frameworks and map themes described in the Forest Ecosystem Management Assessment Team report (FEMAT 1993), in the watershed analysis guide (USDA 1994a), and in the aquatic ecomap report (USDA 1994b).

Scale boundaries are established by physical criteria. Watershed boundaries are delineated from 1:100,000 scale Idaho Transportation Department maps and range from 140 to 93,000 ha. Channel reach type boundaries are delineated from 1:24,000 scale U.S. Geological Survey topographic maps, using gradient and confinement. Habitat types are discrete channel units generally one to 10 wetted widths in thalweg length, distinguished from each other based on geomorphic shape and dominant flow patterns (Hawkins and others

1993; McCain and others 1990). The mesohabitat-scale data are measured or estimated at each habitat type. A field survey is necessary to obtain habitat type and mesohabitat-scale data (Overton and others, in preparation).

Scale Descriptors

The landscape-scale descriptors are used in two ways: (1) to identify and classify homogeneous landscape units believed to be somewhat structurally and functionally alike because they have similar physical features (such as watersheds with similar geology and climate; reach classes with similar gradients, drainage area, and morphology; habitat types with similar flow patterns and morphology); and (2) to group the next lower scale data sets into similar physical settings (physiography, geomorphology) with expected similar operating processes (such as discharge, sediment transport, and deposition) that govern the physical and biological structure and function of that scale (such as aquatic habitat features—channel morphology, substrate, velocity, depth, nutrient retention, space, and food for biological organisms). These groupings, or stratifications, are necessary to assist the user in making meaningful comparisons between land-managed analysis areas and the natural condition data base, and comparisons between scales.

The following discussion covers the scale-specific descriptors that can be used for grouping watersheds and channel reaches:

- Watershed scale—geology, climate, drainage area, and natural disturbance history.
- Channel reach scale—gradient and confinement, elevation, dominant vegetative cover, and drainage area.

Table 4 lists scale descriptors for watersheds, table 5 gives climate data for collector sites, and table 6 lists channel reach type descriptors.

For this report, frequency distributions (relative and cumulative) for the selected habitat variables for all of the surveyed natural condition streams are grouped by channel reach type and geology. More refined groupings can be generated from the natural condition electronic data base. For example, stream reaches can be grouped by drainage area, dominant vegetation class, or elevation. More meaningful comparisons between specific watersheds and reaches will be achieved by matching similar biogeoclimatic descriptors.

Watershed Scale

Watershed-scale descriptors are parent geology, climate, and drainage area. These attributes have significantly influenced the evolutionary development of the watershed and stream channel. They also govern vegetative patterns, soil development, drainage network, erosive mechanisms, and fluvial processes (Easterbrook 1993). Known historical disturbances, natural and human, are also recorded (table 7). The historical human-disturbance information and the field-observed human disturbances were used to ensure that impacts were minor and would not be expected to influence the natural structure and function of the stream reach. Known natural disturbances, such as recent fires, were recorded for the user to assist in analysis.

Geology—Two major, distinct geologies are found in the Salmon River drainage: the Idaho Batholith, a composite mass of granitic plutons, and the Challis Volcanics (see appendix B for details). Much of the modern topography has been formed over the last 2 million years during glacial and interglacial periods of the Pleistocene epoch. Many smaller intrusions into these

Table 4—General descriptors for streams (1991-1993) that represent natural conditions. Watershed areas are calculated from Idaho Transportation Department maps (1:100,000 map scale). Elevations are estimated from U.S. Geological Survey topographical maps (1:24,000 map scale). Parent material is the dominant geology determined from the survey's geological maps (1:250,000 map scale) and knowledgable Forest Service personnel. The index number can be used to locate other stream data in tables 6 and 7 and in appendix A, which contains the on-site photographs.

Index No.	HUC[1]	Stream	Year	Forest	Parent material[2] Gross	Parent material[2] Sub-class	Watershed area	Elevation Lower	Elevation Upper
							ha	------ *m* ------	
1	1	Alpine Creek	1991	Sawtooth	P	G	2,581	2,158	2,170
2	5	Banner Creek	1992	Challis	P	G	3,449	2,035	2,097
3	1	Basin Creek	1992	Challis	P	G	4,967	2,036	2,566
4	5	Beaver Creek	1992	Challis	P	G	14,436	1,969	2,115
5	5	Beaver Creek	1993	Challis	P	G	3,247	2,115	2,219
6	5	Big Chief Creek	1992	Boise	V	B	2,219	1,902	2,060
7	5	Big Cottonwood Creek	1992	Challis	V	R	2,902	1,707	1,979
8	5	Browning Creek	1993	Challis	P	G	1,527	1,905	1,938
9	8	Bum Creek	1993	Payette	P	G	1,288	1,914	2,012
10	5	Cape Horn Creek	1992	Challis	P	G	1,373	2,030	2,072
11	8	Caton Creek	1992	Boise	P	G	4,666	1,756	2,005
12	7	Chamberlain Creek	1993	Payette	P	G	28,074	1,560	1,816
14	7	Chamberlain Cr, W Fk	1993	Payette	P	G	5,217	1,700	2,082
15	1	Champion Creek	1992	Sawtooth	M	M	4,081	2,231	2,304
16	1	Champion Cr, S Fk	1992	Sawtooth	P	G	1,344	2,310	2,536
17	3	Clear Creek	1991	Salmon	P	G	12,940	1,042	1,753
18	8	Cly Creek	1993	Payette	P	G	638	1,670	2,133
19	5	Dynamite Creek	1992	Challis	V	R	3,956	1,618	1,792
20	1	Fishhook Creek	1991	Sawtooth	S	F	3,098	2,066	2,069
21	5	Float Creek	1993	Challis	P	G	2,934	1,792	1,914
22	10	Fry Pan Creek	1991	Payette	V	R	1,250	1,341	1,463
23	1	Garland Creek	1992	Sawtooth	P	G	1,841	2,085	2,252
24	1	Germania Creek	1992	Sawtooth	V/S	R/F	7,850	2,243	2,487
25	1	Goat Creek	1992	Sawtooth	P	G	963	2,036	2,146
26	4	Hayden Cr, E Fk	1992	Salmon	M	Q	3,124	1,835	2,280
27	1	Hell Roaring Creek	1991	Sawtooth	P	G	3,051	2,118	2,198
28	8	Hum Creek	1993	Payette	P	G	546	1,951	2,054
29	5	Indian Creek	1991	Boise	V	B	21,697	1,403	1,902
30	5	Indian Creek	1992	Boise	V	B	4,518	1,902	2,268
31	5	Knapp Creek	1992	Challis	P	G	5,108	2,012	2,158
32	8	Lick Creek	1993	Payette	P	G	8,421	1,219	2,048
33	8	Lick Cr, N Fk	1993	Payette	P	G	2,468	1,286	2,304
34	8	Lick, Trib A	1993	Payette	P	G	140	1,926	1,951
35	8	Lick, Trib B	1993	Payette	P	G	158	2,072	2,292
36	1	Little Basin Creek	1992	Challis	P	G	2,381	1,975	2,075
37	5	Little Indian Creek	1992	Boise	V	R	1,560	1,797	2,041
38	5	Little Pistol Creek	1993	Challis	P	G	13,355	1,536	1,957
39	7	Lodgepole Creek	1993	Payette	P	G	4,807	1,560	1,658
40	5	Loon Creek	1991	Challis	P	G	92,807	1,219	2,133
41	5	Marble Creek	1992	Challis	V	R	33,860	1,280	1,618
42	5	Marsh Creek	1993	Challis	P	G	38,983	1,877	1,981
43	5	Mayfield Cr, E Fk	1991	Challis	V	R	8,414	1,884	2,158
44	7	McCalla Creek	1992	Payette	P	G	4,607	1,829	1,914
45	3	McConn Creek	1993	Salmon	M	Q	3,935	1,451	1,630
46	6	Monumental Cr, W Fk	1992	Payette	V	R	5,806	1,756	1,794
47	8	Mormon Creek	1992	Boise	P	G	1,187	1,890	1,926
48	10	Paradise Creek	1991	Payette	V	R	1,702	1,219	1,524
49	5	Pistol Creek	1993	Challis	P	G	29,551	1,440	1,944
50	5	Porter Creek	1992	Boise	P	G	1,466	1,999	2,005
51	5	Rapid River	1993	Challis	P	G	31,855	1,608	1,938
52	10	Rapid River	1991	Nez Perce	M	M	14,603	988	1,725
53	10	Rapid River	1992	Payette	M	M	27,841	677	1,800
54	10	Rapid R, Granite Fk	1992	Payette	M	M	1,185	1,688	1,877
55	10	Rapid R, Lake Fk	1991	Payette	M	M	2,969	1,487	1,597
56	10	Rapid R, Lake Fk	1992	Payette	M	M	2,726	1,585	1,682
57	6	Rush Creek	1992	Payette	P	G	24,468	1,169	1,256
58	6	Rush Creek	1993	Payette	P	G	23,619	1,256	1,548

(con.)

Table 4 (Con.)

Index No.	HUC[1]	Stream	Year	Forest	Parent material[2] Gross	Sub-class	Watershed area	Elevation Lower	Upper
							ha	m	m
60	3	Salmon R, N Fk	1992	Salmon	M	Q	3,212	1,707	1,792
61	3	Sheep Creek	1992	Salmon	M	Q	7,810	1,417	1,487
62	8	Split Creek	1993	Payette	P	G	834	1,387	1,768
63	5	Sulphur Creek	1991	Challis	P	G	12,697	1,743	1,810
64	1	Sunday Creek	1992	Challis	P	G	1,068	2,094	2,128
65	1	Swimm Creek	1992	Sawtooth	P	G	956	2,060	2,195
66	8	Tamarack Creek	1992	Payette	M	Q	4,768	1,682	1,731
67	8	Tamarack Creek	1993	Payette	M	Q	4,373	1,731	2,073
68	5	Trail Creek	1992	Challis	P	G	6,862	1,560	1,682
69	8	Tsum Creek	1993	Payette	P	G	812	1,658	2,341
70	3	Twin Creek	1992	Salmon	M	Q	2,693	1,731	1,798
71	5	Vanity Creek	1993	Challis	P	G	4,800	1,835	1,981
72	5	Warm Spring Creek	1991	Challis	V	R	24,990	1,524	2,121
73	1	Warm Springs Creek	1992	Sawtooth	P	G	15,764	2,009	2,089
74	7	Whimstick Creek	1992	Payette	P	G	6,997	1,707	1,731
75	7	Whimstick Cr, E Fk	1992	Payette	P	G	1,636	1,731	1,829
76	7	Whimstick Cr, S Fk	1992	Payette	P	G	2,885	1,719	1,756
77	7	Whimstick Cr, W Fk	1992	Payette	P	G	1,939	1,719	1,734
78	6	Wilson Creek	1991	Salmon	P	G	5,060	1,792	1,975
79	5	Winnemucca Creek	1993	Challis	P	G	3,373	2,048	2,145
80	3	Woodtick Creek	1991	Salmon	M	Q	4,144	1,628	1,676

[1]Hydrologic Unit Code (HUC) that corresponds to figure 3 for locating streams and linking streams to climate data (table 5).
[2]Gross geology classification breakdown codes: M = Metamorphic; P = Plutonic; V = Volcanic; S = Sedimentary. Subclass geology classification breakdown codes: B = Basalt/Andesite; F = Fine; M = Metasediment; G = Granitic; Q = Quartzite; R = Rhyolite.

Table 5—Climate summary data for the listed collector sites scattered throughout the Salmon River Basin. The table is to be used with figure 3 to assist in locating climate data appropriate for the streams that represent natural conditions.

Site No.	Collector site	HUC	Elevation	Average precipitation	Air temperature Normal	Normal minimum	Normal maximum	Data source[1]
			m	cm	°C	°C	°C	
1	Banner Summit	5	2,146	105.7	2.37	–4.18	10.43	*
2	Bear Basin	10	1,631	94.5	2.79	–4.35	10.86	*
3	Big Creek Summit	8	2,006	123.4	2.51	–2.68	8.42	*
4	Brundage Reservoir	10	1,920	138.2	3.01	–3.84	10.15	*
5	Campbell Ferry	7	704	61.0	8.90	1.50	16.30	+
6	Challis	1	1,577	19.6	6.70	–0.06	13.90	#
7	Cobalt	3	1,527	39.6	13.60	–3.70	5.00	#
8	Deadwood Summit	8	2,091	146.3	0.95	–7.10	9.15	*
9	Dixie	7	1,713	75.2	2.10	–6.20	10.40	#
10	Galena Summit	1	2,676	80.3	0.72	–4.60	7.44	*
11	Gibbonsville	3	1,359	40.4	5.30	–3.20	13.80	+
12	Leadore 2	4	1,829	21.4	3.80	–5.50	13.10	+
13	May	2	1,558	20.9	6.30	–2.50	15.20	#
14	Meadowlake	4	2,789	85.1	0.66	–3.78	5.56	*
15	Middle Fork Lodge	5	1,366	41.4	6.20	–2.50	14.80	+
16	Mill Creek Summit	1	2,682	78.5	0.38	–5.48	7.50	*
17	Moose Creek	3	1,890	80.8	1.80	–4.36	10.00	*
18	Morgan Creek	1	2,316	66.3	**	**	**	*
19	Mountain Meadows	7	1,939	120.7	3.20	–6.79	11.33	*
20	New Meadows RS	10	1,180	63.0	5.10	–3.60	13.70	#
21	Riggins	10	549	44.3	12.20	5.60	18.80	#
22	Salmon KSRA	3	1,198	25.6	7.40	–0.40	15.20	#
23	Secesh Summit	8	1,987	129.5	3.19	–3.70	10.78	*
24	Shoup	3	1,036	39.0	7.70	0.50	15.20	+
25	Slate Creek RS	9	485	43.3	12.30	4.70	19.90	+
26	Stanley	1	1,911	41.6	1.70	–7.70	11.10	#
27	Taylor Ranch	6	1,170	35.7	6.60	–1.10	14.20	+
28	Warren	7	1,800	68.8	3.10	–5.90	11.90	#
29	Yellowpine 7S	8	1,554	70.5	3.60	–5.30	12.40	+

[1]Data source codes: * = Snotel data (temperature data averaged from monthly averages); # = data from "Monthly normals of temperature, precipitation, and heating and cooling days" (1961-1990); + = NOAA climate data (temperature data and precipitation data averaged from monthly averages), normal temperatures averaged from monthly minimum and maximum averages.
** No temperature data available.

Table 6—Specific information on channel reach type cover class (wooded/meadow), elevation, and drainage area for streams that represent natural conditions. Index numbers can be used to locate companion stream descriptor data in tables 4 and 7.

Index No.	Stream	Reach No.	Channel reach type cover class[1]	Elevation Lower	Elevation Upper	Drainage area
				- - - - - - - *m* - - - - - - - -		*ha*
1	Alpine Creek	1	C-wooded	2,158	2,170	2,581
2	Banner Creek	1	C-wooded	2,035	2,037	3,449
		2	B-wooded	2,037	2,094	3,403
		3	C-meadow	2,094	2,097	2,395
3	Basin Creek	9	B-wooded	2,036	2,060	4,967
		10	B-wooded	2,060	2,566	2,087
4	Beaver Creek	1	B-wooded	1,969	1,975	14,436
		2	C-wooded	1,975	1,981	14,261
		3	B-wooded	1,981	1,990	14,070
		4	C-wooded	1,990	1,999	13,378
		5	C-wooded	1,999	2,031	12,006
		6	C-wooded	2,031	2,042	11,723
		7	C-wooded	2,042	2,054	10,537
		8	C-wooded	2,054	2,073	8,129
		9	C-wooded	2,073	2,091	6,527
		10	B-wooded	2,091	2,115	3,437
5	Beaver Creek	11	B-wooded	2,115	2,196	3,247
		12	B-wooded	2,196	2,219	2,290
6	Big Chief Creek	1	B-wooded	1,902	2,060	2,219
7	Big Cottonwood Cr	1	B-wooded	1,707	1,979	2,902
8	Browning Creek	1	B-wooded	1,905	1,938	1,527
9	Bum Creek	1	B-wooded	1,914	2,012	1,288
10	Cape Horn Creek	3	B-wooded	2,030	2,072	1,373
11	Caton Creek	1	B-wooded	1,756	1,810	4,666
		2	B-wooded	1,810	1,834	3,101
		3	B-wooded	1,834	2,005	2,504
12	Chamberlain Creek	8	B-wooded	1,560	1,621	28,074
		9	B-meadow	1,621	1,658	22,394
		12	C-meadow	1,707	1,737	12,977
		13	B-wooded	1,737	1,792	11,261
		14	C-wooded	1,792	1,816	6,969
14	Chamberlain Cr, W Fk	2	B-meadow	1,700	2,082	5,217
15	Champion Creek	9	B-wooded	2,243	2,295	3,835
		10	B-wooded	2,295	2,312	3,365
16	Champion Cr, S Fk	1	A-wooded	2,312	2,350	1,369
		2	B-wooded	2,350	2,365	1,353
		3	A-wooded	2,365	2,374	1,182
		4	B-wooded	2,374	2,457	1,175
		5	A-wooded	2,457	2,502	1,084
		6	B-wooded	2,502	2,551	1,030
17	Clear Creek	2	B-wooded	1,042	1,753	12,940
18	Cly Creek	1	B-wooded	1,670	1,731	638
		2	A-wooded	1,731	1,914	628
		3	B-wooded	1,914	2,060	548
		4	A-wooded	2,060	2,121	394
		5	C-wooded	2,121	2,133	157
19	Dynamite Creek	1	B-wooded	1,618	1,707	3,956
		2	A-wooded	1,707	1,792	2,087
20	Fishhook Creek	1	C-meadow	2,066	2,069	3,098
21	Float Creek	1	B-wooded	1,792	1,914	2,934
22	Fry Pan Creek	1	B-wooded	1,341	1,463	1,250
23	Garland Creek	1	A-wooded	2,079	2,171	1,823
		2	B-wooded	2,171	2,195	1,750
24	Germania Creek	8	B-wooded	2,252	2,274	6,918
		9	B-wooded	2,274	2,320	6,262
		10	B-wooded	2,320	2,347	3,523
		11	A-wooded	2,347	2,380	2,812
		13	B-meadow	2,393	2,426	1,496
		14	C-wooded	2,426	2,451	1,337
		15	B-wooded	2,451	2,560	1,016
25	Goat Creek	4	C-meadow	2,063	2,082	867
		5	B-wooded	2,082	2,085	767
		6	C-wooded	2,085	2,097	732
		7	B-wooded	2,097	2,134	634

(con.)

Table 6 (Con.)

Index No.	Stream	Reach No.	Channel reach type cover class[1]	Elevation Lower	Elevation Upper	Drainage area
				- - - - - - - m	- - - - - - - -	ha
26	Hayden Cr, E Fk	1	B-wooded	1,835	1,951	3,124
		2	B-wooded	1,951	2,243	3,001
		3	B-wooded	2,243	2,280	1,840
27	Hell Roaring Creek	1	C-wooded	2,118	2,191	3,051
		2	C-wooded	2,191	2,198	2,839
28	Hum Creek	2	C-wooded	1,951	1,987	546
		3	B-wooded	1,987	2,011	264
		4	A-wooded	2,011	2,054	206
29	Indian Creek	1	C-wooded	1,403	1,405	21,697
		2	B-wooded	1,405	1,494	21,635
		3	B-wooded	1,494	1,498	18,702
		4	B-wooded	1,498	1,594	15,641
		5	B-wooded	1,594	1,640	14,111
		6	B-wooded	1,640	1,695	13,048
		7	B-wooded	1,695	1,719	11,173
		8	B-wooded	1,719	1,750	10,728
		9	B-wooded	1,750	1,772	9,514
		10	B-wooded	1,772	1,797	8,859
		11	C-wooded	1,797	1,864	7,317
		12	C-wooded	1,864	1,902	5,432
30	Indian Creek	13	B-wooded	1,902	2,268	4,518
31	Knapp Creek	1	C-meadow	2,012	2,044	5,108
		2	C-wooded	2,044	2,073	5,066
		3	C-wooded	2,073	2,121	4,142
		4	B-wooded	2,121	2,158	2,990
32	Lick Creek	1	B-wooded	1,219	1,289	8,421
		2	B-wooded	1,289	1,396	8,127
		3	A-wooded	1,396	1,457	5,043
		4	A-wooded	1,457	1,597	4,755
		5	A-wooded	1,597	1,658	3,592
		6	A-wooded	1,658	1,670	3,050
		7	A-wooded	1,670	1,890	2,196
		8	C-meadow	1,890	1,951	747
		9	A-wooded	1,951	2,048	563
33	Lick Cr, N Fk	1	A-wooded	1,286	1,387	2,468
		2	A-wooded	1,387	1,792	2,278
		3	B-wooded	1,792	1,890	1,252
		4	A-wooded	1,890	2,304	1,012
34	Lick, Trib A	1	A-wooded	1,926	1,951	140
35	Lick, Trib B	1	A-wooded	2,072	2,292	158
36	Little Basin Creek	1	B-wooded	1,975	2,075	2,381
37	Little Indian Creek	1	B-wooded	1,797	2,041	1,560
38	Little Pistol Creek	1	B-wooded	1,536	1,560	13,355
		2	B-wooded	1,560	1,632	12,985
		3	B-wooded	1,632	1,680	11,124
		4	B-wooded	1,680	1,704	9,089
		5	B-wooded	1,704	1,776	7,968
		6	B-wooded	1,776	1,896	6,912
		7	A-wooded	1,896	1,957	3,262
39	Lodgepole Creek	1	B-wooded	1,560	1,658	4,807
40	Loon Creek	1	B-wooded	1,219	1,231	92,807
		2	B-wooded	1,231	1,273	92,761
		3	B-wooded	1,273	1,308	88,725
		4	B-wooded	1,308	1,318	87,595
		5	B-wooded	1,318	1,361	87,167
		6	B-wooded	1,361	1,419	86,234
		7	C-meadow	1,419	1,430	84,101
		8	C-meadow	1,430	1,443	82,816
		11	B-wooded	1,466	1,482	79,743
		12	B-wooded	1,482	1,521	72,632
		13	B-wooded	1,521	1,572	68,189
		14	B-wooded	1,572	1,635	41,862
		24	B-wooded	1,800	1,824	9,239
		25	B-wooded	1,824	2,012	8,787
		26	A-wooded	2,012	2,133	2,510

(con.)

Table 6 (Con.)

Index No.	Stream	Reach No.	Channel reach type cover class[1]	Elevation Lower	Elevation Upper	Drainage area
				- - - - - - - *m* - - - - - - - -		*ha*
41	Marble Creek	1	B-wooded	1,280	1,405	33,860
		2	B-wooded	1,405	1,487	32,756
		3	B-wooded	1,487	1,500	29,515
		4	B-wooded	1,500	1,530	27,474
		5	B-wooded	1,530	1,536	25,768
		6	B-wooded	1,536	1,554	24,886
		7	B-wooded	1,554	1,576	17,708
		8	B-wooded	1,576	1,580	17,152
		9	B-wooded	1,580	1,600	16,218
		10	B-wooded	1,600	1,615	15,531
		11	B-wooded	1,615	1,618	14,910
42	Marsh Creek	1	B-wooded	1,877	1,951	38,983
		2	B-wooded	1,951	1,969	37,233
		3	B-wooded	1,969	1,981	35,515
43	Mayfield Cr, E Fk	1	B-wooded	1,884	1,993	8,414
		2	C-wooded	1,993	2,085	7,234
		3	C-wooded	2,085	2,118	5,619
44	McCalla Creek	1	C-meadow	1,804	1,817	4,607
		2	C-meadow	1,817	1,829	4,340
		3	B-wooded	1,829	1,914	4,296
45	McConn Creek	1	B-wooded	1,451	1,630	3,935
46	Monumental Cr, W Fk	1	C-wooded	1,756	1,780	5,806
		2	C-wooded	1,780	1,794	4,891
47	Mormon Creek	1	B-wooded	1,890	1,926	1,187
48	Paradise Creek	1	A-wooded	1,219	1,524	1,702
49	Pistol Creek	1	B-wooded	1,440	1,518	29,551
		2	B-wooded	1,518	1,584	27,905
		3	B-wooded	1,584	1,656	14,034
		4	B-wooded	1,656	1,704	10,566
		5	B-wooded	1,704	1,737	9,794
		6	B-wooded	1,737	1,752	9,621
		7	B-wooded	1,752	1,800	8,857
		8	B-wooded	1,800	1,848	6,761
		9	B-wooded	1,848	1,944	5,366
50	Porter Creek	4	C-meadow	1,999	2,005	1,466
51	Rapid River (1993)	1	B-wooded	1,488	1,584	31,855
		2	C-wooded	1,584	1,606	30,748
		3	B-wooded	1,606	1,631	29,754
		4	B-wooded	1,631	1,640	27,995
		5	B-wooded	1,640	1,661	27,673
		6	B-wooded	1,661	1,689	26,343
		7	B-wooded	1,689	1,728	22,612
51	Rapid River	8	B-wooded	1,728	1,762	20,880
		9	B-wooded	1,762	1,776	19,527
		10	B-wooded	1,776	1,792	17,550
		11	B-wooded	1,792	1,824	16,225
		12	B-wooded	1,824	1,872	12,747
		13	B-wooded	1,872	1,896	7,689
		14	B-wooded	1,896	1,905	7,335
		15	B-wooded	1,905	1,915	6,491
		16	B-wooded	1,915	1,938	6,130
53	Rapid River (1992)	4	B-wooded	677	701	27,841
		5	B-wooded	701	725	27,531
		6	B-wooded	725	823	27,135
		7	B-wooded	823	920	25,715
		8	B-wooded	920	988	15,988
52	Rapid River (1991)	9	A-wooded	988	1,048	14,603
		10	B-wooded	1,048	1,219	13,177
		11	B-wooded	1,219	1,426	10,620
		12	A-wooded	1,426	1,500	5,920
		13	B-wooded	1,500	1,555	5,771
		14	A-wooded	1,555	1,609	2,690
		15	B-wooded	1,609	1,725	2,612
53	Rapid River (1992)	16	B-wooded	1,725	1,734	1,989
		17	A-wooded	1,734	1,780	1,503
		18	B-wooded	1,780	1,800	1,068

(con.)

Table 6 (Con.)

Index No.	Stream	Reach No.	Channel reach type cover class[1]	Elevation Lower	Elevation Upper	Drainage area
				- - - - - - - m - - - - - - - -		ha
54	Rapid R, Granite Fk	1	B-wooded	1,688	1,877	1,185
55	Rapid R, Lake Fk	1	B-wooded	1,487	1,597	2,969
56	Rapid R, Lake Fk	2	B-wooded	1,588	1,682	2,726
57	Rush Creek	1	B-wooded	1,169	1,256	24,468
58	Rush Creek	2	B-wooded	1,256	1,439	23,619
		3	B-wooded	1,439	1,530	16,894
		4	B-wooded	1,530	1,548	12,921
60	Salmon River,N Fk	9	B-wooded	1,707	1,792	3,212
		10	A-wooded	1,792	1,865	1,155
61	Sheep Creek	4	A-wooded	1,417	1,426	7,810
		5	B-wooded	1,426	1,487	6,512
62	Split Creek	1	A-wooded	1,387	1,768	834
63	Sulphur Creek	1	C-meadow	1,743	1,777	12,697
		2	C-wooded	1,777	1,798	10,330
		3	C-wooded	1,798	1,810	8,703
64	Sunday Creek	1	B-wooded	2,094	2,128	1,068
65	Swimm Creek	1	A-wooded	2,060	2,110	952
		2	B-wooded	2,110	2,195	945
66	Tamarack Creek	1	B-wooded	1,682	1,731	4,768
67	Tamarack Creek	2	B-wooded	1,731	1,914	4,373
		3	A-wooded	1,914	2,073	2,426
68	Trail Creek	1	B-wooded	1,560	1,695	6,862
		2	A-wooded	1,695	1,682	5,891
69	Tsum Creek	1	A-wooded	1,658	1,670	812
		2	A-wooded	1,670	1,987	788
		3	B-wooded	1,987	2,097	664
		4	A-wooded	2,097	2,341	194
70	Twin Creek	2	B-wooded	1,731	1,780	2,693
		3	B-wooded	1,780	1,798	2,497
71	Vanity Creek	1	B-wooded	1,835	1,871	4,800
		2	B-wooded	1,871	1,981	3,235
72	Warm Spring Creek	1	B-wooded	1,524	1,609	24,990
		2	B-wooded	1,609	1,634	24,097
		3	B-wooded	1,634	1,658	23,120
		4	C-wooded	1,658	1,707	19,920
		5	C-wooded	1,707	1,734	19,365
		6	C-wooded	1,734	1,756	16,305
		7	B-wooded	1,756	1,780	14,814
		8	B-wooded	1,780	1,820	14,363
		9	B-wooded	1,820	1,853	11,904
		10	B-wooded	1,853	1,917	11,110
		11	B-wooded	1,917	2,121	4,475
73	Warm Springs Creek	1	C-meadow	2,009	2,012	15,764
		2	C-meadow	2,082	2,089	12,250
74	Whimstick Creek	1	B-meadow	1,707	1,731	6,997
75	Whimstick Cr, E Fk	1	B-wooded	1,731	1,829	1,636
76	Whimstick Cr, S Fk	1	C-meadow	1,719	1,756	2,885
77	Whimstick Cr, W Fk	1	C-meadow	1,719	1,734	1,939
		2	B-meadow	1,734	1,853	1,890
78	Wilson Creek	1	B-wooded	1,792	1,975	5,060
79	Winnemucca Creek	1	C-wooded	2,048	2,145	3,373
80	Woodtick Creek	1	B-wooded	1,628	1,676	4,144

[1]Channel reach type codes: A = confined, > 4% gradient, source channel; B = moderately confined, 1.5 to 4.0% gradient, transport channel; C = unconfined, <1.5% gradient, response channel.

Table 7—Streams that represent natural conditions, their master basins, and a brief disturbance history. The index number links this table to stream data tables 4 and 6 and appendix A. All streams listed are influenced by fire frequency; most have probably experienced fire within the last 50 years. However, only documented occurrences (mostly recent) have been included in this table.

Index No.	Stream	Basin (Tributary/Section of the Salmon River)	Disturbance history
1	Alpine Creek	Alturas Lake Cr/Upper	Recreation[1]
2	Banner Creek	Marsh Cr/Middle Fk	Highway, campground[1]
3	Basin Creek	Basin Cr/Upper	Cattle grazing, road, trail, recreation[1]
4, 5	Beaver Creek	Marsh Cr/Middle Fk	Road, campground, recreation, trail, sheep grazing[1]
6	Big Chief Creek	Indian Cr/Middle Fk	Hiking trail[1]
7	Big Cottonwood Creek	Marble Cr/Middle Fk	No impacts[1]
8	Browning Creek	Pistol Cr/Middle Fk	No impacts[1]
9	Bum Creek	Tamarack Cr/E Fk S Fk	Minimal impacts[3]
10	Cape Horn Creek	Marsh Cr/Middle Fk	Old road[1]
11	Caton Creek	Caton Cr/E Fk S Fk	2,000 acre wildfire in 1942[4], hiking trail[5]
12	Chamberlain Creek	Chamberlain Cr/Lower	Trail, trail crossing[3]
14	Chamberlain Cr, W Fk	Chamberlain Cr/Lower	Trail crossing[3]
15	Champion Creek	Champion Cr/Upper	Trail, cattle grazing[1]
16	Champion Cr, S Fk	Champion Cr/Upper	No impacts[1]
17	Clear Creek	Panther Cr/Middle	Trail, historic grazing[2]
18	Cly Creek	Lick Cr/Secesh R/S Fk	Sheep grazing[3]
19	Dynamite Creek	Marble Cr/Middle Fk	No impacts[1]
20	Fishhook Creek	Redfish Lake Cr/Upper	Trail, recreation[1]
21	Float Creek	Rapid R/Middle Fk	Road[1]
22	Fry Pan Creek	Rapid R/Little	Trail, recreation, cattle and sheep grazing[1]
23	Garland Creek	Warm Springs Cr/Upper	Trail[1]
24	Germania Creek	Germania Cr/E Fk	Cattle grazing, trail, road, mining[1]
25	Goat Creek	Valley Cr/Upper	Cattle pre-1984[1]
26	Hayden Cr, E Fk	Lemhi R/Middle	Cattle grazing[2], diversions[3]
27	Hell Roaring Creek	Hell Roaring Cr/Upper	Road, trail, recreation[1]
28	Hum Creek	Lick Cr/Secesh R/S Fk	Trail, recreation[3]
29, 30	Indian Creek	Indian Cr/Middle Fk	Trail[6], recreation[1]
31	Knapp Creek	Marsh Cr/Middle Fk	Diversions, road, cattle and sheep grazing, trail[1]
32	Lick Creek	Lick Cr/Secesh R/S Fk	Road, bridge, sheep, recreation, two-track road[3]
33	Lick Cr, N Fk	Lick Cr/Secesh R/S Fk	Road, bridge, trail, trail crossing, timber harvest, horses, recreation[3]
34	Lick Cr, Trib A	Lick Cr/Secesh R/S Fk	Bridge, trail crossing[3]
35	Lick Cr, Trib B	Lick Cr/Secesh R/S Fk	Recent fire[3]
36	Little Basin Creek	Basin Cr/Upper	Cattle grazing[1]
37	Little Indian Creek	Indian Cr/M Fk	No impacts[1]
38	Little Pistol Creek	Pistol Cr/Middle Fk	Trail[1]
39	Lodgepole Creek	Chamberlain Cr/Lower	Minimal impacts[3]
40	Loon Creek	Loon Cr/Middle Fk	Trail, livestock grazing, road, mining, campground, airstrip, irrigation[1], cables, administrative site[6]
41	Marble Creek	Marble Cr/Middle Fk	Trail[1]
42	Marsh Creek	Marsh Cr/Middle Fk	Trail, trailhead, campground[1]
43	Mayfield Cr, E Fk	Loon Cr/Middle Fk	Trail[1]
44	McCalla Creek	Chamberlain Cr/Lower	Minimal impacts[1]
45	McConn Creek	Indian Cr/Middle	Minimal historic mining[2]
46	Monumental Cr, W Fk	Big Cr/Middle Fk	Trail, minimal historic mining[1]
47	Mormon Creek	Mormon Cr/S Fk	Timber sale in 1960's (approx. 640 acres)[7], road[5], 440 acre wildfire in 1990[4]

(con.)

Table 7 (Con.)

Index No.	Stream	Basin (Tributary/Section of the Salmon River)	Disturbance history
48	Paradise Creek	Rapid R/Little	Sheep grazing, trail[1]
49	Pistol Creek	Pistol Cr/Middle Fk	Private ranch[6], trail[1]
50	Porter Creek	Bear Valley Cr/Middle Fk	Historic cattle/sheep use, light cattle grazing, horse use[8], 986 acre wildfire in 1990[4], hiking trail[5]
51	Rapid River	Rapid R/Middle Fk	Trail, road[1]
52, 53	Rapid River	Rapid R/Little	Trail crossings, cattle grazing, fire in 1989[1]
54	Rapid R, Granite Fk	Rapid R/Little	No impacts[1]
55, 56	Rapid R, Lake Fk	Rapid R/Little	Recreation, trail, sheep grazing[1]
57, 58	Rush Creek	Big Cr/Middle Fk	Trail[3], fire in 1991[1]
60	Salmon R, N Fk	N Fk/Middle	Road, development, timber, diversion, access road, trail crossings[2]
61	Sheep Creek	N Fk/Middle	Road, trail, recreation, development, diversion, historic mining[2], access road[3]
62	Split Creek	Lick Cr/Secesh R/S Fk	Trail, trail crossing[3]
63	Sulphur Creek	Sulphur Cr/Middle Fk	Trail, ranch, horse use[1]
64	Sunday Creek	Basin Cr/Upper	Trail[1]
65	Swimm Creek	Warm Springs Cr/Upper	No impacts[1]
66, 67	Tamarack Creek	Tamarack Cr/E Fk S Fk	Trail, camps[3]
68	Trail Creek	Marble Cr/Middle Fk	No impacts[1]
69	Tsum Creek	Lick Cr/Secesh R/S Fk	Minimal impacts[3]
70	Twin Creek	Twin Cr/N Fk	Trail[1]
71	Vanity Creek	Rapid R/Middle Fk	Road[1]
72	Warm Spring Creek	Loon Cr/Middle Fk	Trail, livestock grazing, ranch, road, mining[1]
73	Warm Springs Creek	Warm Springs Cr/Upper	Cattle grazing, trail, recreation, fire in 1960's[1]
74	Whimstick Creek	Chamberlain Cr/Lower	Minimal impacts[1]
75	Whimstick Cr, E Fk	Chamberlain Cr/Lower	Fire in 1988[1]
76	Whimstick Cr, S Fk	Chamberlain Cr/Lower	Fire in 1988[1]
77	Whimstick Cr, W Fk	Chamberlain Cr/Lower	Fire in 1988[1]
78	Wilson Creek	Wilson Cr/Middle Fk	Trail[1]
79	Winnemucca Creek	Marsh Cr/Upper	Road, trail[1]
80	Woodtick Creek	Panther Cr/Middle	Trail[2], roads, timber harvest[1]

[1]Personal communication with National Forest and Intermountain Research Station fisheries biologists.
[2]Salmon National Forest biological assessment, 1993.
[3]Comments and/or slides from fish habitat data collection, 1991-1993. Fish habitat data were obtained using R1/R4 Fish and Fish Habitat Standard Inventory Procedures (1991, 1992).
[4]Boise National Forest Wildfire History Map, 1987.
[5]Boise National Forest maps, transportation series, 1991.
[6]Management plan for the Frank Church-River of No Return Wilderness, 1985.
[7]Boise National Forest Timber Sale Map, no date.
[8]Boise National Forest, Lowman Ranger District, Stage II Environmental Analysis Report for Elk Creek C&H Grazing Allotment, 1974.

broad geologic areas result in drainages that have unique geologic composition (table 4). Champion Creek in the Stanley Valley, for example, flows along a fault separating two geologies.

The dominant geology was determined for the watershed of each stream (table 4) with the help of Forest Service district geologists and biologists, Intermountain Research Station physical scientists, and 1:250,000 scale U.S. Geological Survey maps. Subclasses, if known, are used to stratify the data to a finer level. The following is the geology classification breakdown:

Gross:	Plutonic (intrusive)	Volcanic (extrusive)	Metamorphic	Sedimentary
Subclass:	Granitic	Basalt/Andesite	Quartzitic	Coarse
	Dioritic	Rhyolite	Metasediment	Fine

Climate—Data describing the climate at each study stream location were not available, but various Snow Telemetry (SNOTEL) and National Oceanic and Atmospheric Administration (NOAA) climate data collection sites are located in the Salmon River Basin. The site number (fig. 3) can be used to locate the site in the climate data table (table 5) and to obtain approximate climate data for the specific streams or stream reaches. Values were obtained or calculated from values found in various sources including SNOTEL and NOAA climate data summaries, and a NOAA summary report (U.S. Department of Commerce 1992). The averages used are based over 30 years when possible, but this varies depending upon how long the collection site has been in operation.

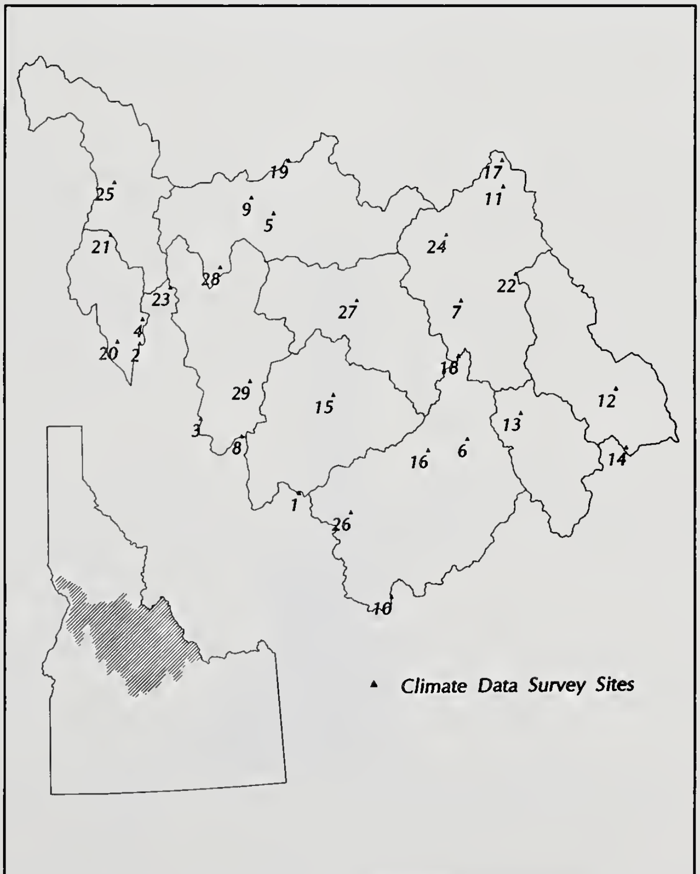

Figure 3—Climate data survey site numbers.

Temperature information for SNOTEL sites was calculated by averaging monthly means. For NOAA sites, the mean-maximum and mean-minimum temperatures were averaged to derive the average normal temperatures. Values found in English units were converted to metric units. All other values were taken directly from the sources sited in table 5.

Drainage Area—Drainage area was calculated from Idaho Transportation Department 1:100,000 scale maps for each watershed (table 4) using planimetry. The approximate watershed boundaries were hand drawn for each reach that was surveyed by the inventory crews. Statistical summaries were not grouped by drainage areas for this report. However, individual watersheds can be grouped and summarized using the electronic media data base. Variables compared by like-drainage areas will be more meaningful (Overton and others 1993).

Stream size and upstream slope at a given point in the stream network determine the energy or power that is a major driver in shaping stream channels (Easterbrook 1993; Leopold and others 1964). Stream size influences channel reach types, habitat types, sediment routing, substrate size, debris movement and placement, and sinuosity. Pool and large woody debris frequencies are reported by mean wetted width changes, which indicate stream size. Figure 4 displays the frequency distribution for stream wetted widths that are represented by the natural condition data base.

Disturbance—We concluded that human alteration of the study stream reaches was insignificant. Records of disturbance history (table 7), however, are sketchy and based on recollections of forest personnel or general planning documents. Many disturbances such as cattle grazing, fire suppression, and

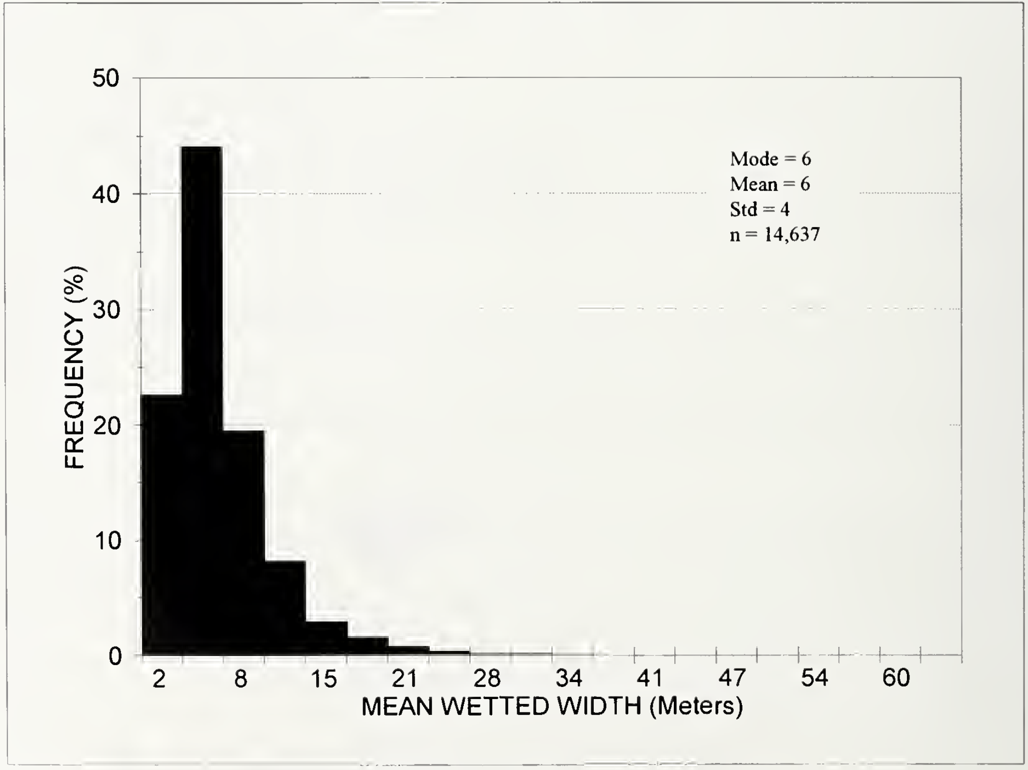

Figure 4—Frequency distribution displaying the range of wetted widths for natural condition streams.

timber harvesting were historically present within some watersheds, and some grazing (mainly trespass) may continue today. Even streams that have existed historically within wilderness boundaries are disturbed by recreationists and other activities, but we characterized these as minor. Some streams are not in protected areas but have not recently been altered by major human-induced disturbances.

Fire by lightning strikes is the primary natural disturbance, followed by high intensity, short duration mountain thunderstorms. The entire Salmon River Basin had experienced less than normal precipitation 3 years prior to the survey and through 1992. Normal precipitation occurred through the fall to spring season of 1993. Although the effects of this drought on the habitat attributes are unknown, one would expect vegetation density and vigor to be less and sediment transport discharges reduced, possibly resulting in more upslope and in-channel sediment storage. These stored sediments will be redistributed when spring flows or mountain thunderstorms generate sufficient overland flow or discharge to transport.

We suggest that when conducting an analysis on an area, detailed natural disturbance history (location, size, duration) be researched to accompany management-related disturbance to assist in the assessment of current and potential habitat conditions.

Channel Reach Type

Three channel reach types (coded: "A", "B", "C") are used to group channel reaches by similar morphological valley shape (confinement) and gradient. These reach types are synonymous with Montgomery and Buffington's (1993) valley segments—source, transport, and response; and Rosgen's (1985) basic channel types ("A", "B", "C"). Valley segments have similar morphologies and governing geomorphic processes (Montgomery and Buffington 1993). These processes, operating at the reach type scale, influence bed forms at the lower scale.

Channel reach type descriptors consist of gradient, confinement, vegetative cover class (wooded versus meadow for "C" reach types), elevation, and drainage area. This scale is primarily used to group reaches with these similar descriptors to facilitate lower scale (habitat type, mesohabitat) data set comparisons. Although delineation of channel reach types is often unclear because of the subtle transitions in gradient and confinement between them, the Rosgen (1985) like classification is used extensively by many agencies. This provides a common link to share data and knowledge across large geographical areas.

Channel reach types can be further classed into the finer Rosgen (1985) channel types by using the substrate component collected by the inventory. Channel reach type was used as a stratifier to facilitate the comparison between channel morphologies with similar sediment and transport characteristics—source, transport, and response.

Gradient and Confinement—The channel reach types are classified as "source," "transport," or "response" based on the map-determined gradient and confinement (confinement = floodplain width versus channel width):

- Source = greater than 4 percent gradient, confined.
- Transport = 1.5 to 4 percent gradient, moderately confined.
- Response = less than 1.5 percent gradient, unconfined.

Gradient and confinement largely govern sediment deposition and transport processes and bed form. These geomorphic processes play an important role

in the structure and function of the aquatic biota and in predicting the response point of the channel to disturbance regimes.

Elevation—Elevation, determined from 1:24,000 scale U.S. Geological Survey topographic maps, is a permanent reference that can be used to group channel reach classes into like elevations. Elevation is recorded at the lower boundary of each reach. Statistical summaries are not grouped by elevation for this report. However, the user can group specific reaches using the electronic data base. Figure 5 is an example of relative frequency distribution for bank stability for "C"-meadow granitic stream reaches with elevations between 1,800 and 2,100 m. Stream and reach elevations are given in tables 4 and 6, respectively.

Elevation influences the vegetative composition of riparian areas, the extremes in seasonal ambient air temperature, and the extent to which precipitation is stored as snow. Elevation is also a surrogate for water temperature—a determining factor in describing fish distributions.

Dominant Vegetative Cover—Vegetative cover class for "C" channel reach types are either wooded (forested) or meadow (nonforested), determined from aerial photos or the field inventory. All other reach types would be forested. Riparian and upslope vegetation is used to group channel reach types for comparison. Statistical summaries are not grouped by vegetative cover class. However, the user can group specific reaches by using the electronic data base. Figure 6 is an example of a relative frequency distribution for bank stability for "C"-wooded granitic stream reaches. Figure 7 displays "C"-meadow granitic stream reaches.

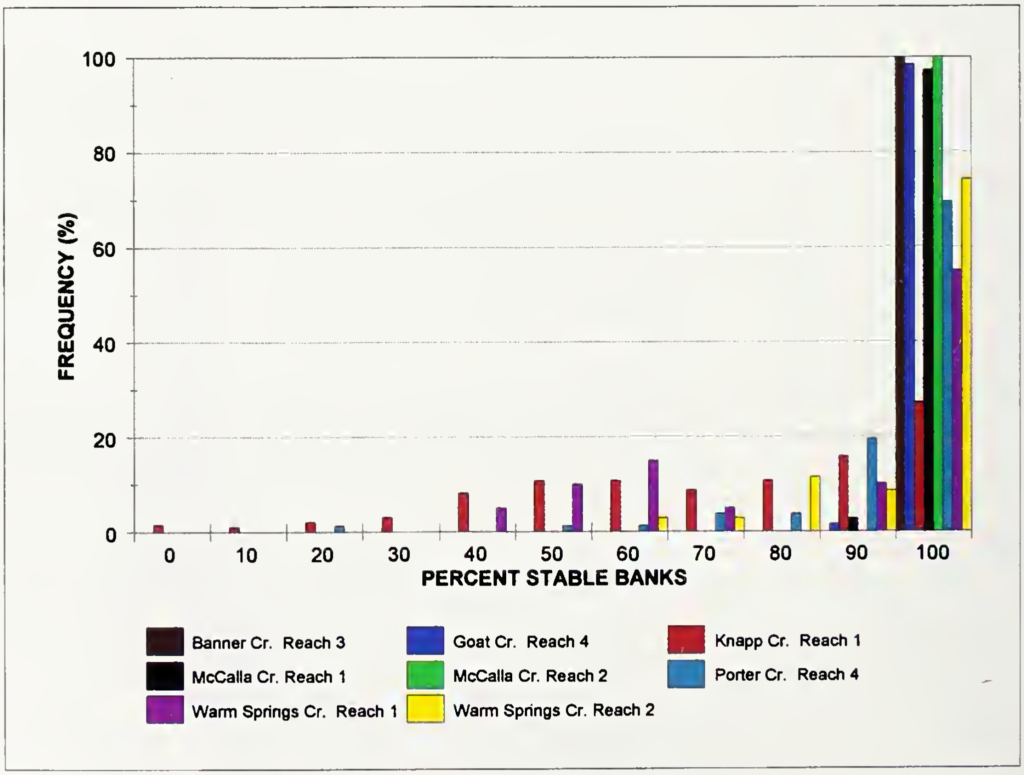

Figure 5—Frequency distribution displaying the range of percent bank stability for "C"-meadow granitic stream reaches with elevations between 1,800 and 2,100 m.

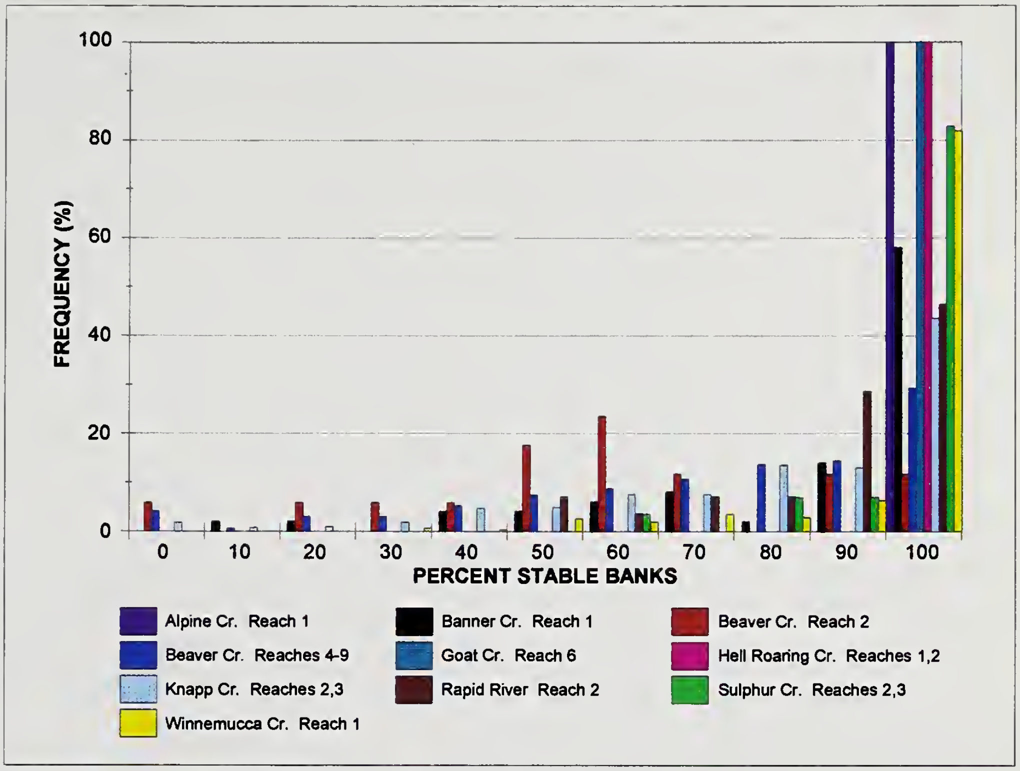

Figure 6—Frequency distribution displaying the range of percent bank stability or "C"-wooded granitic stream reaches.

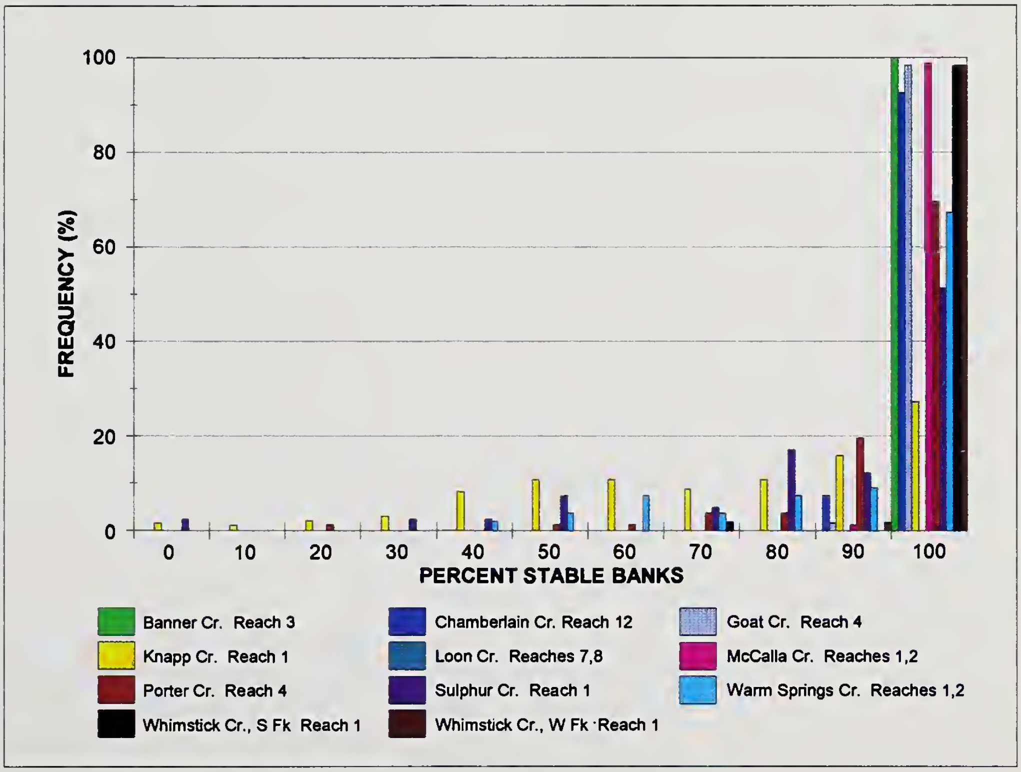

Figure 7—Frequency distribution displaying the range of percent bank stability for "C"-meadow granitic stream reaches.

The cover class designation helps the user identify channel attributes that are expected to be influencing channel morphology, such as forced pools formed by large woody debris (forced pools) (Montgomery and Buffington 1993) versus meander-formed pools, common in meadows containing broad floodplains with bank vegetation of grasses, sedges, and shrubs.

Drainage Area—Drainage area is calculated to the downstream end of the channel reach (not including the tributary drainage area used to break the reach) from Idaho Transportation Department 1:100,000 scale maps using planimetry. Drainage area can be used to group the reaches for comparing like-stream sizes. Reach summaries are not grouped by drainage area. However, the user can group specific reaches by using the electronic data base. Figure 8 is an example of relative frequency distribution for bank stability for "C"-meadow granitic stream reaches with drainage areas less than 10,000 ha, while figure 9 is for stream reaches with drainage areas between 10,000 to 100,000 ha.

Stream size has a major influence on channel morphology—discharge, stream power, productivity, and channel morphology (Clifton 1989; Easterbrook 1993; Leopold and others 1964; Vannote and others 1980). We found habitat variable comparisons required grouping by drainage area to detect differences (Overton and others 1993). Ralph and others (1994) concurred with this.

Habitat Type Scales

Habitat types were first described by Bisson and others (1982) and have been modified by others to characterize habitats across a wide range of streams (Bozek and Rahel 1991; Hankin and Reeves 1988; Kozel 1987; Lobb and Orth 1991; McCain and others 1990; Modde and others 1991; Overton and others 1993).

At the habitat type scale, a hierarchical scheme is used to classify channel units. Pools (slow water) and riffles (fast water) are at the top of the hierarchy. Pools can be further broken down based on flow characteristics (lateral, straight, dammed, plunge) and forming features that cause flow divergence directed by inchannel debris or pattern (such as wood, meander, boulder, bedrock, beaver). Riffles can be further broken down primarily dependent on gradient and substrate size. This habitat typing hierarchical scheme is described by Hawkins and others (1993).

The habitat type scale is the primary stratifying unit in the R1/R4 Fish and Fish Habitat Standard Inventory Procedures (Overton and others, in preparation) for collecting and summarizing habitat type attribute data (mesohabitat scale data) for a stream reach or for grouped or like-habitat types. Examples are the frequency distributions for bank stability for "C"-meadow granitic stream reaches grouped by specific habitat types: meander-formed lateral scour pools (fig. 10) and low gradient riffles (fig. 11). Only reach statistical summaries are reported in this document. However, finer resolution can be obtained by grouping at the habitat type scale (figs. 10, 11). Frequency distribution sample sizes refer to the number of habitat types used to calculate the statistical summaries.

Mesohabitat Scale

The mesohabitat scale are attributes of the habitat types (see table 3 for a list of variables; field collection procedures will be published in Overton and others, in preparation). Mesohabitat-scale data describe the geometric dimensions of the individual habitat type (length, width, depth) and characterize banks, substrate, and large woody debris. These data are used to generate the summary statistics reported in this document for the reach scale. The attributes describing natural conditions at the mesohabitat scale are covered extensively in the next section.

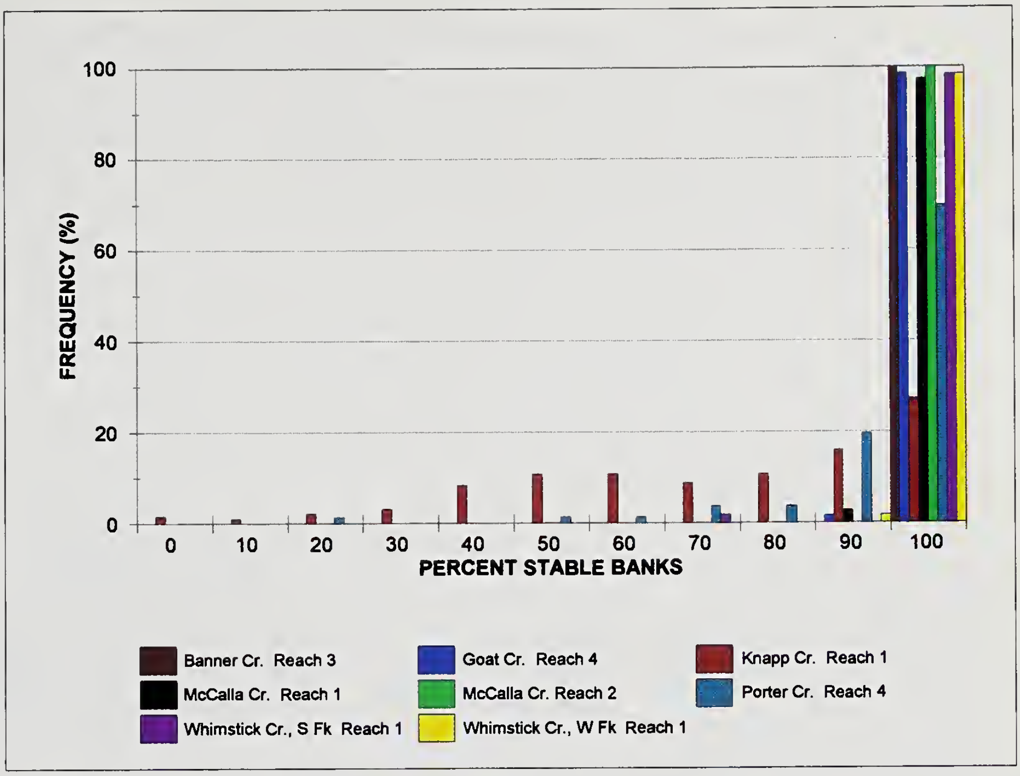

Figure 8—Frequency distribution displaying the range of percent bank stability for "C"-meadow granitic stream reaches with drainage areas less than 10,000 ha.

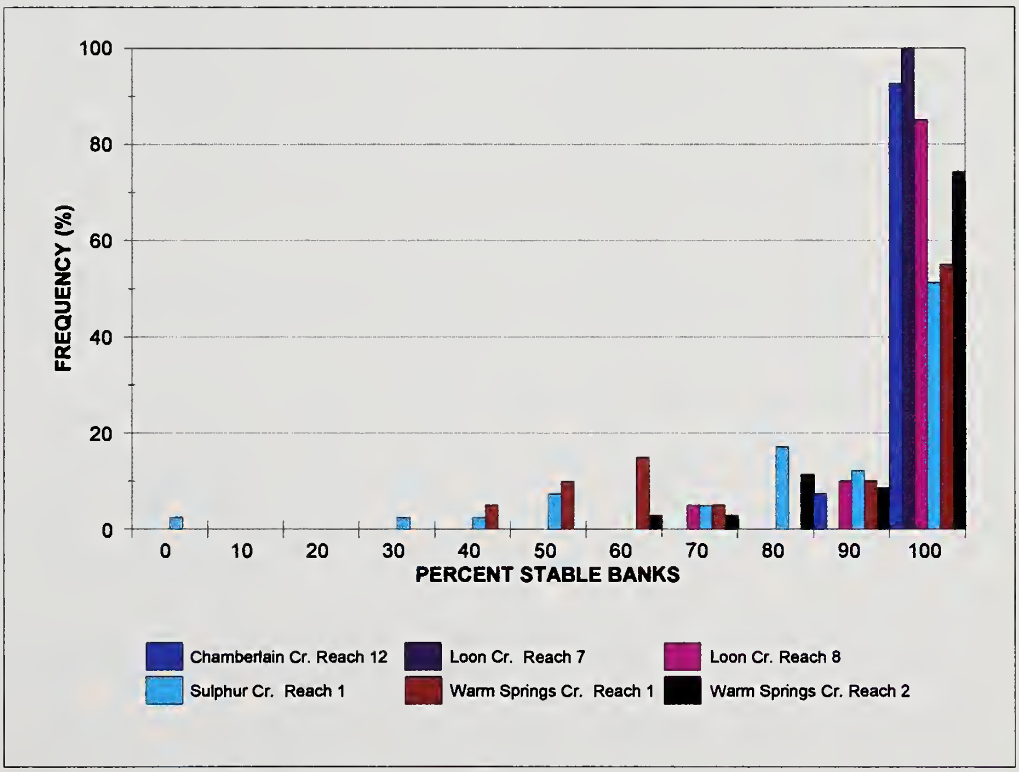

Figure 9—Frequency distribution displaying the range of percent bank stability for "C"-meadow granitic stream reaches with drainage areas between 10,000 and 100,000 ha.

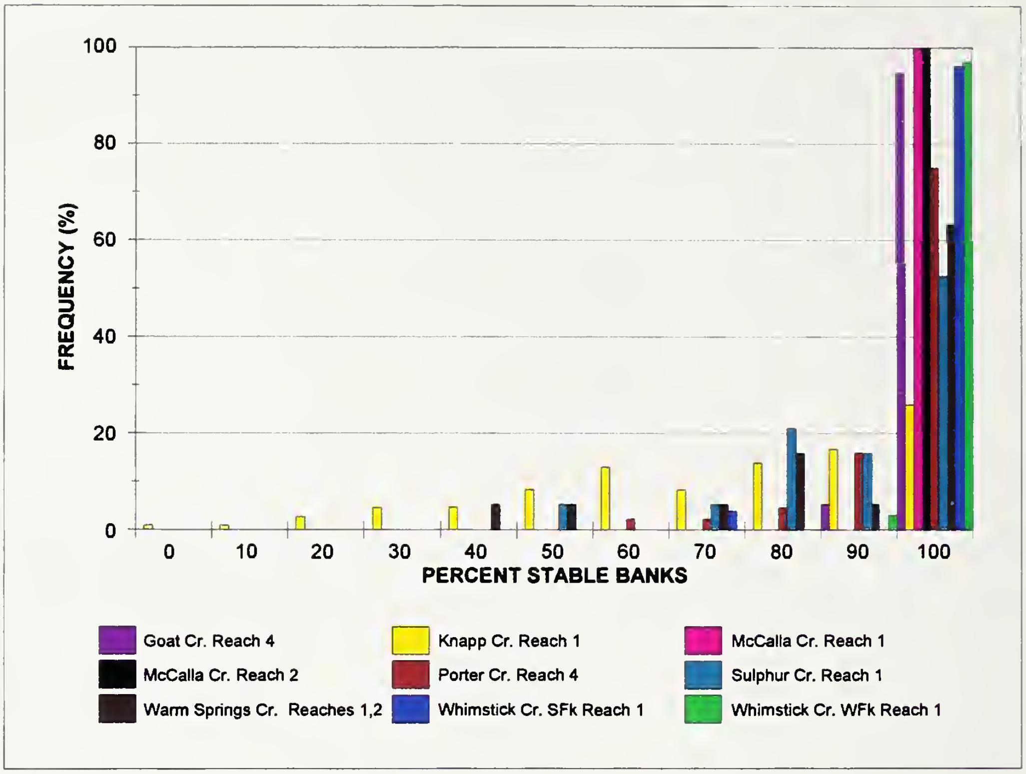

Figure 10—Frequency distribution displaying the range of percent bank stability for "C"-meadow granitic stream reaches grouped by meander-formed lateral scour pools.

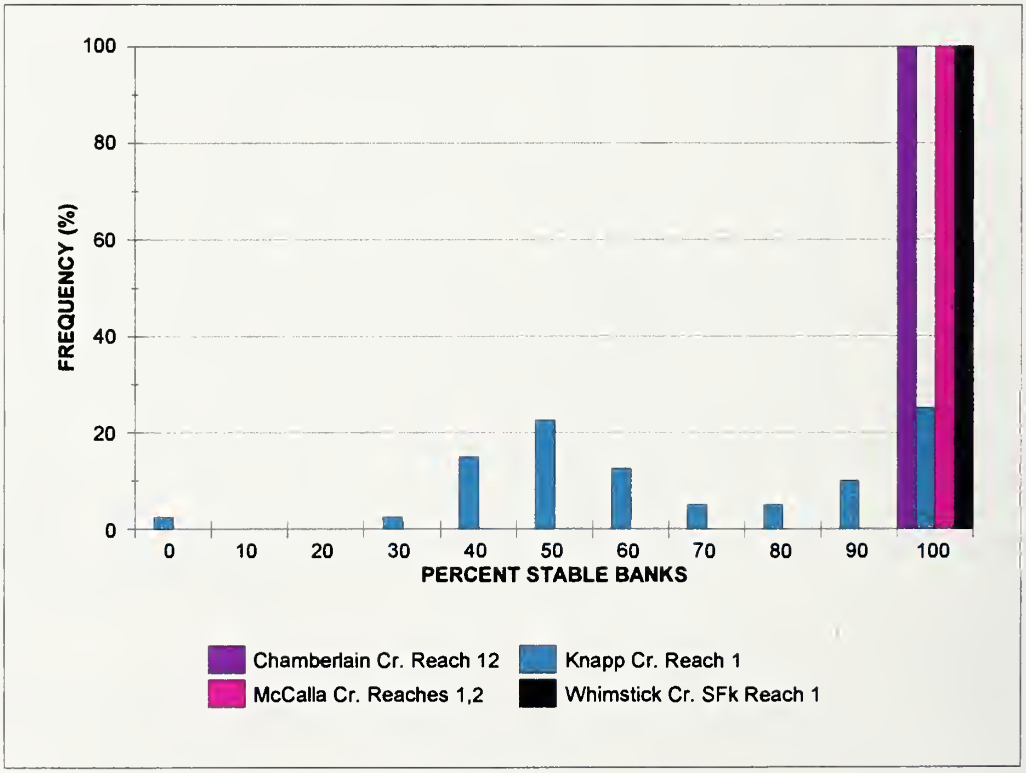

Figure 11—Frequency distribution displaying the range of percent bank stability for "C"-meadow granitic stream reaches grouped by low gradient riffles.

Natural Condition Descriptors

We have initially selected eight variables to represent natural condition descriptors of stream channels: percent bank stability, percent bank undercut, water temperature, width-to-depth ratio, width-to-maximum-depth ratio, surface fines, large woody debris frequency, and pool frequency by stream size classes. These variables, except for surface fines and percent bank undercut, coincide with most of the current PACFISH (FEMAT 1993; USDA FS and USDI BLM 1995) variables that represent features of good anadromous fish habitat in Western streams (table 2). The natural condition statistical summaries are from streams that represent a variety of wetted widths (fig. 4) and elevations ranging from 650 to 2,550 m (tables 4 and 6).

The statistical summaries—mean, standard deviation, mode, number of observations (habitat types), relative frequency distributions, and cumulative relative frequency distributions—were grouped three ways: (1) for all streams combined, (2) by channel reach type, and (3) by gross geology and channel reach type. Pool and large woody debris counts by linear distance are grouped by channel width classes (tables 8 and 9). Pool and large woody debris frequencies were generated using the SAS statistical package (SAS Institute, Inc. 1988). Relative frequency distributions and cumulative relative frequency distributions, means, standard deviations, and modes are displayed for percent bank stability, percent bank undercut, water temperature, width-to-depth and width-to-maximum-depth ratios, and surface fines grouped as described above. These graphs were generated using a combination of software (dBaseIV, QuattroPro, PSI-Plot).

Some errors remain within the data base due to mislabeled field observations (such as misplaced decimals) and data entry errors. Known errors were corrected. Those remaining should have minimal effect on the summaries that have large sample sizes.

Although field measurements were taken at one time, temporal variability should be similar to the spatial diversity observed from a large number of streams across the Salmon River Basin. This assumes that watersheds are not in synchrony in regards to natural succession and disturbance.

Table 8—Pool frequencies for the various wetted width classes for streams that represent natural conditions; stratified by overall, geology, channel type, and channel type and geology. This table uses English measurements.

					All streams					
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile	39.00	59.64	48.02	39.02	22.66	22.78	18.15	10.16	9.41	4.05
Standard error	20.83	13.65	4.16	3.46	2.18	2.53	3.78	1.05	1.31	0.79
Number of observations	2	23	43	44	38	32	17	14	15	5
Number of LWD/mile	175.71	156.73	201.51	189.80	100.58	119.95	86.90	83.63	42.66	42.41
Standard error	135.76	32.32	17.88	19.44	14.08	14.08	11.00	15.54	7.14	16.92
Number of observations	3	24	43	43	38	32	17	14	16	5
					Plutonic					
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile	39.00	68.80	51.83	46.79	24.88	22.94	15.09	8.29	9.32	4.05
Standard error	20.83	16.63	6.01	4.54	4.10	3.42	2.18	1.20	1.40	0.79
Number of observations	2	18	25	26	19	20	8	8	14	5
Number of LWD/mile	175.71	182.45	236.81	195.53	128.69	143.81	94.84	94.54	42.23	42.41
Standard error	135.76	38.30	25.17	23.46	17.65	18.95	11.57	20.57	7.62	16.92
Number of observations	3	19	25	26	19	20	8	8	15	5

(con.)

Table 8 (Con.)

Volcanic										
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile		22.67	46.03	26.52	21.86	25.47	26.64	11.82	10.66	
Standard error		13.96	9.67	3.57	1.71	4.62	12.17	1.26	**	
Number of observations		4	7	8	14	9	5	5	1	
Number of LWD/mile		51.73	142.00	170.10	44.07	81.20	86.05	64.87	49.14	
Standard error		33.80	34.24	60.29	5.01	20.17	33.39	29.59	**	
Number of observations		4	7	8	14	9	5	5	1	

Metamorphic										
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile		42.76	40.65	28.81	18.07	13.66	13.67	16.84		
Standard error		**	6.54	7.20	2.73	3.48	3.39	**		
Number of observations		1	11	10	4	3	4	1		
Number of LWD/mile		87.90	159.16	190.78	167.96	77.11	72.09	90.06		
Standard error		**	25.69	40.41	86.41	8.96	12.02	**		
Number of observations		1	11	9	4	3	4	1		

Sedimentary										
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile					10.15					
Standard error					**					
Number of observations					1					
Number of LWD/mile					88.13					
Standard error					**					
Number of observations					1					

"A" channels										
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile	18.17	10.81	33.84	24.42	15.04	8.61	5.59	2.13		
Standard error	**	4.90	8.66	7.92	2.63	**	**	**		
Number of observations	1	5	12	9	3	1	1	1		
Number of LWD/mile	238.63	225.21	174.74	191.59	227.35	111.89	106.16	204.55		
Standard error	208.35	92.01	30.02	48.57	99.37	**	**	**		
Number of observations	2	6	12	8	3	1	1	1		

"B" channels										
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile	59.83	60.55	53.06	40.10	24.28	20.46	15.38	10.64	7.76	3.94
Standard error	**	20.39	4.93	4.14	2.76	2.28	1.61	1.08	1.07	1.40
Number of observations	1	12	26	28	26	22	14	11	12	3
Number of LWD/mile	49.86	170.72	216.62	206.83	95.13	112.84	79.05	75.41	41.54	49.38
Standard error	**	40.71	22.75	25.05	15.01	15.11	9.23	15.38	8.15	29.69
Number of observations	1	12	26	28	26	22	14	11	13	3

"C" channels										
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile		98.51	55.86	53.49	20.52	30.02	43.85	11.57	16.02	4.22
Standard error		24.38	10.56	6.44	4.47	6.65	30.20	0.26	2.73	0.52
Number of observations		6	5	7	9	9	2	2	3	2
Number of LWD/mile		60.26	187.17	119.64	74.09	138.23	132.22	68.38	47.53	31.95
Standard error		24.24	73.01	28.32	15.70	34.76	77.60	32.58	17.36	6.00
Number of observations		6	5	7	9	9	2	2	3	2

"A" channel/plutonic										
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile	18.17	10.81	28.17	16.66	14.85	8.61		2.13		
Standard error	**	4.90	10.03	4.38	**	**		**		
Number of observations	1	5	8	4	1	1		1		
Number of LWD/mile	238.63	225.21	177.48	192.61	145.23	111.89		204.55		
Standard error	208.35	92.01	34.12	52.40	**	**		**		
Number of observations	2	6	8	4	1	1		1		

"A" channel/volcanic										
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile			33.23	2.74						
Standard error			19.00	**						
Number of observations			2	1						
Number of LWD/mile			80.96	54.89						
Standard error			2.63	**						
Number of observations			2	1						

(con.)

Table 8 (Con.)

					"A" channel/metamorphic					
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile			57.11	37.59	15.13		5.59			
Standard error			33.20	15.50	4.55		**			
Number of observations			2	4	2		1			
Number of LWD/mile			257.58	235.80	268.41		106.15			
Standard error			105.70	111.50	156.72		**			
Number of observations			2	3	2		1			
					"B" channel/plutonic					
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile	59.83	74.91	62.28	50.00	26.92	21.81	15.29	8.22	7.76	3.94
Standard error	**	29.22	7.58	5.70	5.21	3.18	2.51	1.04	1.07	1.40
Number of observations	1	8	13	16	13	13	7	5	12	3
Number of LWD/mile	49.86	219.98	277.67	221.50	140.99	144.32	100.58	83.01	41.54	49.38
Standard error	**	51.62	34.22	32.66	23.56	21.29	11.59	19.28	8.15	29.69
Number of observations	1	8	13	16	13	13	7	5	13	3
					"B" channel/volcanic					
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile		28.19	59.26	30.82	21.76	20.95	14.79	11.82		
Standard error		18.13	10.93	1.08	2.18	4.40	3.57	1.26		
Number of observations		3	4	6	11	6	4	5		
Number of LWD/mile		66.95	196.72	206.27	45.94	62.50	55.11	64.87		
Standard error		42.69	41.26	75.73	6.21	8.91	16.18	29.59		
Number of observations		3	4	6	11	6	4	5		
					"B" channel/metamorphic					
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile		42.76	36.99	22.96	21.00	13.66	16.37	16.84		
Standard error		**	5.05	6.50	2.63	3.48	2.91	**		
Number of observations		1	9	6	2	3	3	1		
Number of LWD/mile		87.90	137.28	168.27	67.51	77.11	60.74	90.06		
Standard error		**	19.20	33.60	7.73	8.96	5.57	**		
Number of observations		1	9	6	2	3	3	1		
					"C" channel/plutonic					
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile		117.00	65.14	58.33	21.58	27.77	13.65	11.57	18.70	4.23
Standard error		19.48	6.50	5.02	8.08	9.13	**	0.26	0.88	0.52
Number of observations		5	4	6	5	6	1	2	2	2
Number of LWD/mile		71.09	222.66	128.19	93.40	148.04	54.62	68.38	46.72	31.95
Standard error		26.56	82.37	31.94	23.94	46.42	**	32.58	30.04	6.00
Number of observations		5	4	6	5	6	1	2	2	2
					"C" channel/volcanic					
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile		6.09	18.71	24.45	22.21	34.52	74.05		10.66	
Standard error		**	**	**	1.29	9.90	**		**	
Number of observations		1	1	1	3	3	1		1	
Number of LWD/mile		6.09	45.21	68.33	37.22	118.61	209.82		49.14	
Standard error		**	**	**	5.09	58.60	**		**	
Number of observations		1	1	1	3	3	1		1	
					"C" channel/sedimentary					
Wetted width in feet	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-65	65-100
Number of pools/mile					10.15					
Standard error					**					
Number of observations					1					
Number of LWD/mile					88.13					
Standard error					**					
Number of observations					1					

**No data available.

Table 9—Pool frequencies for the various wetted width classes for streams that represent natural conditions; stratified by overall, geology, channel type, and channel type and geology. This table uses metric measurements.

					All streams					
Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m	2.42	3.71	2.98	2.42	1.41	1.42	1.13	0.63	0.58	0.25
Standard error	1.29	0.85	0.26	0.22	0.14	0.16	0.23	0.07	0.08	0.05
Number of observations	2	23	43	44	38	32	17	14	15	5
Number of LWD/100 m	10.92	9.74	12.52	11.79	6.25	7.45	5.40	5.20	2.65	2.64
Standard error	8.44	2.01	1.11	1.21	0.87	0.87	0.68	0.97	0.44	1.05
Number of observations	3	24	43	43	38	32	17	14	16	5
					Plutonic					
Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m	2.42	4.28	3.22	2.91	1.55	1.43	0.94	0.52	0.58	0.25
Standard error	1.29	1.03	0.37	0.28	0.25	0.21	0.14	0.07	0.09	0.05
Number of observations	2	18	25	26	19	20	8	8	14	5
Number of LWD/100 m	10.92	11.34	14.72	12.15	8.00	8.94	5.89	5.87	2.62	2.64
Standard error	8.44	2.38	1.56	1.46	1.10	1.18	0.72	1.28	0.47	1.05
Number of observations	3	19	25	26	19	20	8	8	15	5
					Volcanic					
Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m		1.41	2.86	1.65	1.36	1.58	1.66	0.73	0.66	
Standard error		0.87	0.60	0.22	0.11	0.29	0.76	0.08	**	
Number of observations		4	7	8	14	9	5	5	1	
Number of LWD/100 m		3.21	8.82	10.57	2.74	5.05	5.35	4.03	3.05	
Standard error		2.10	2.13	3.75	0.31	1.25	2.07	1.84	**	
Number of observations		4	7	8	14	9	5	5	1	
					Metamorphic					
Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m		2.66	2.53	1.79	1.12	0.85	0.85	1.05		
Standard error		**	0.41	0.45	0.17	0.22	0.21	**		
Number of observations		1	11	10	4	3	4	1		
Number of LWD/100 m		5.46	9.89	11.85	10.44	4.79	4.48	5.60		
Standard error		**	1.60	2.51	5.37	0.56	0.75	**		
Number of observations		1	11	9	4	3	4	1		
					Sedimentary					
Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m					0.63					
Standard error					**					
Number of observations					1					
Number of LWD/100 m					5.48					
Standard error					**					
Number of observations					1					
					"A" channels					
Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m	1.13	0.67	2.10	1.52	0.93	0.54	0.35	0.13		
Standard error	**	0.30	0.54	0.49	0.16	**	**	**		
Number of observations	2	6	12	9	3	1	1	1		
Number of LWD/100 m	14.83	14.0	10.86	11.91	14.13	6.95	6.60	12.71		
Standard error	12.95	5.72	1.87	3.02	6.17	**	**	**		
Number of observations	2	6	12	8	3	1	1	1		
					"B" channels					
Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m	3.72	3.76	3.30	2.49	1.51	1.27	0.96	0.66	0.48	0.24
Standard error	**	1.27	0.31	0.26	0.17	0.14	0.10	0.07	0.07	0.09
Number of observations	1	12	26	28	26	22	14	11	12	3
Number of LWD/100 m	3.10	10.61	13.46	12.85	5.91	7.01	4.91	4.69	2.58	3.07
Standard error	**	2.53	1.41	1.56	0.93	0.94	0.57	0.96	0.51	
Number of observations	1	12	26	28	26	22	14	11	13	3
					"C" channels					
Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m		6.12	3.47	3.32	1.28	1.87	2.72	0.72	1.0	0.26
Standard error		1.51	0.66	0.40	0.28	0.41	1.88	0.02	0.17	0.03
Number of observations		6	5	7	9	9	2	2	3	2
Number of LWD/100 m		3.74	11.63	7.43	4.60	8.59	8.22	4.25	2.95	1.99
Standard error		1.51	4.54	1.76	0.98	2.16	4.82	2.02	1.08	0.37
Number of observations		6	5	7	9	9	2	2	3	2

(con.)

Table 9 (Con.)

"A" channel/plutonic

Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m	1.13	0.67	1.75	1.04	0.92	0.54		0.13		
Standard error	**	0.30	0.62	0.27	**	**		**		
Number of observations	1	5	8	4	1	1		1		
Number of LWD/100 m	14.83	13.99	11.03	11.97	9.02	6.95		12.71		
Standard error	12.95	5.72	2.12	3.26	**	**		**		
Number of observations	2	6	8	4	1	1		1		

"A" channel/volcanic

Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m			2.06	0.17						
Standard error			1.18	**						
Number of observations			2	1						
Number of LWD/100 m			5.03	3.41						
Standard error			0.16	**						
Number of observations			2	1						

"A" channel/metamorphic

Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m			3.55	2.34	0.94		0.35			
Standard error			2.06	0.96	0.28		**			
Number of observations			2	4	2		1			
Number of LWD/100 m			16.01	14.65	16.68		6.60			
Standard error			6.57	6.93	9.74		**			
Number of observations			2	3	2		1			

"B" channel/plutonic

Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m	3.72	4.65	3.87	3.11	1.67	1.36	0.95	0.51	0.48	0.24
Standard error	**	1.82	0.47	0.35	0.32	0.20	0.16	0.06	0.07	0.09
Number of observations	1	8	13	16	13	13	7	5	12	3
Number of LWD/100 m	3.10	13.67	17.25	13.76	8.76	8.97	6.25	5.16	2.58	3.07
Standard error	**	3.21	2.13	2.03	1.46	1.32	0.72	1.20	0.51	1.84
Number of observations	1	8	13	16	13	13	7	5	13	3

"B" channel/volcanic

Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m		1.75	3.68	1.92	1.35	1.30	0.92	0.73		
Standard error		1.13	0.68	0.07	0.14	0.27	0.22	0.08		
Number of observations		3	4	6	11	6	4	5		
Number of LWD/100 m		4.16	12.22	12.82	2.85	3.88	3.42	4.03		
Standard error		2.65	2.56	4.71	0.39	0.55	1.01	1.84		
Number of observations		3	4	6	11	6	4	5		

"B" channel/metamorphic

Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m		2.66	2.30	1.43	1.30	0.85	1.02	1.05		
Standard error		**	0.31	0.40	0.16	0.22	0.18	**		
Number of observations		1	9	6	2	3	3	1		
Number of LWD/100 m		5.46	8.53	10.46	4.19	4.79	3.77	5.60		
Standard error		**	1.19	2.09	0.48	0.56	0.35	**		
Number of observations		1	9	6	2	3	3	1		

"C" channel/plutonic

Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m		7.27	4.05	3.62	1.34	1.72	0.85	0.72	1.16	0.26
Standard error		1.21	0.40	0.31	0.50	0.57	**	0.02	0.05	0.03
Number of observations		5	4	6	5	6	1	2	2	2
Number of LWD/100 m		4.42	13.84	7.96	5.80	9.20	3.40	4.25	2.90	1.98
Standard error		1.65	5.12	1.98	1.49	2.88	**	2.02	1.87	0.37
Number of observations		5	4	6	5	6	1	2	2	2

"C" channel/volcanic

Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m		0.38	1.16	1.52	1.38	2.14	4.60		0.66	
Standard error		**	**	**	0.08	0.62	**		**	
Number of observations		1	1	1	3	3	1		1	
Number of LWD/100 m		0.38	2.81	4.25	2.31	7.37	13.04		3.05	
Standard error		**	**	**	0.32	3.64	**		**	
Number of observations		1	1	1	3	3	1		1	

"C" channel/sedimentary

Wetted width in meters	0-1.5	1.5-3	3-4.7	4.7-6	6-7.6	7.6-9.2	9.2-10.7	10.7-12.2	12.2-19.8	19.8-30.5
Number of pools/100 m					0.63					
Standard error					**					
Number of observations					1					
Number of LWD/100 m					5.48					
Standard error					**					
Number of observations					1					

**No data available.

Frequency Distributions

The frequency distribution is a count of how frequently a value occurs among the set of observations. Because we have a large data set, the data must be condensed and summarized into a more compact and interpretable form. The frequency distribution allows us to quickly view the data set's range from low to high, and at what values we see clustering.

The data have been converted to relative frequencies (fig. 12) and cumulative relative frequencies (fig. 13). Relative frequencies (fig. 12) are helpful in determining the percent occurrence of that observation in relation to the other observations. For example, total stable banks (100 percent stable) made up 52 percent of the observations (fig. 12). This frequency distribution also displays how the data are skewed. For example, figure 12 data are skewed to the left. Because of this skewed distribution, the mean (84) has little value in regard to identifying the central tendency for bank stability.The most logical measure of central tendency is the mode, the value that occurs most frequently.

The cumulative relative frequency example (fig. 13) lets us quickly determine how many observations are above or below a particular value. For example, figure 13 indicates that approximately 15 percent of the habitat types had 50 percent or less bank stability, approximately 70 percent of the habitat types had better than 80 percent bank stability, and 60 percent of the habitat types had 90 percent or better bank stability. Figures 12 and 13 quickly characterize bank stability for low gradient (less than 1.5 percent), unconfined, plutonic geology channel reach types.

The following section describes stream channel attributes that represent natural condition variables. Detailed field measurement and recording procedures will be found in the R1/R4 Fish and Fish Habitat Standard Inventory Procedures (Overton and others, in preparation). Appendix C provides a general description of the electronic data base queries used to generate the frequency distributions.

Bank Instability

Bank instability can be initiated by natural events (extreme floods, wildfires, mass wasting) or human disturbances (grazing, logging, roads, urban developments, gravel operations) that change discharge, sediment load, and channel stability (MacDonald and others 1991). Bank material and vegetation type and density also affect the stability of banks (Platts 1984). Eroding streambanks support little or no riparian vegetation, resulting in a loss of stream shading, bank undercut, nutrient loading, and terrestrial insect drop into the stream. This can affect salmonids by increasing summertime stream temperatures, reducing wintertime temperatures resulting in the formation of anchor ice, reducing cover through a lack of bank undercut or overhead vegetation cover, and depositing sediment. All this will reduce depths, interstitial gravel spaces, and pool volumes; and decrease terrestrial and aquatic fish food items (Meehan 1991).

A stable streambank, as viewed at the steepest sloped portion of the channel between the bankfull and existing water level, shows no evidence of active erosion, breakdown, tension cracking, or shearing. An unstable streambank shows evidence of active erosion and/or slumping; undercut banks are considered stable until tension fractures show on the ground surface at the back of the undercut. Left and right bank lengths are estimated separately, as bank lengths may not be equal. Every portion of each bank is accounted for. Stable banks are expressed as a percentage of the total estimated bank length (includes left and right bank) for each habitat type. Figures 14 through 39 are the statistical summaries for percent bank stability grouped by all surveyed stream reaches, by channel reach types, and by channel reach types and geology.

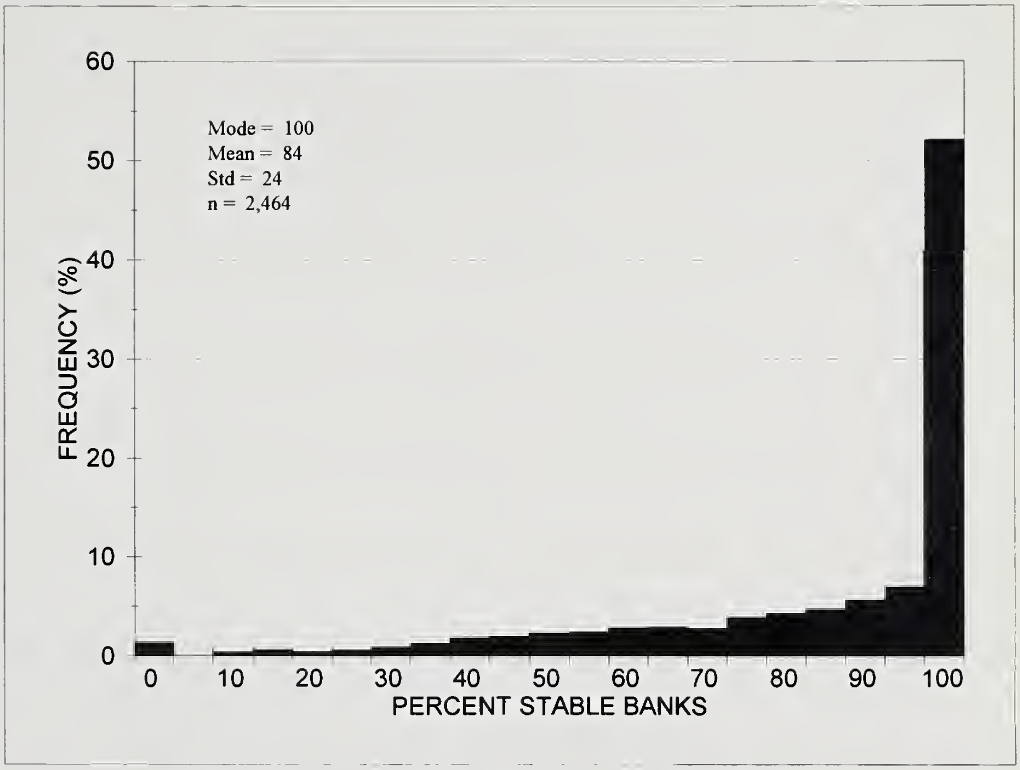

Figure 12—An example relative frequency distribution for a selected habitat variable—bank stability.

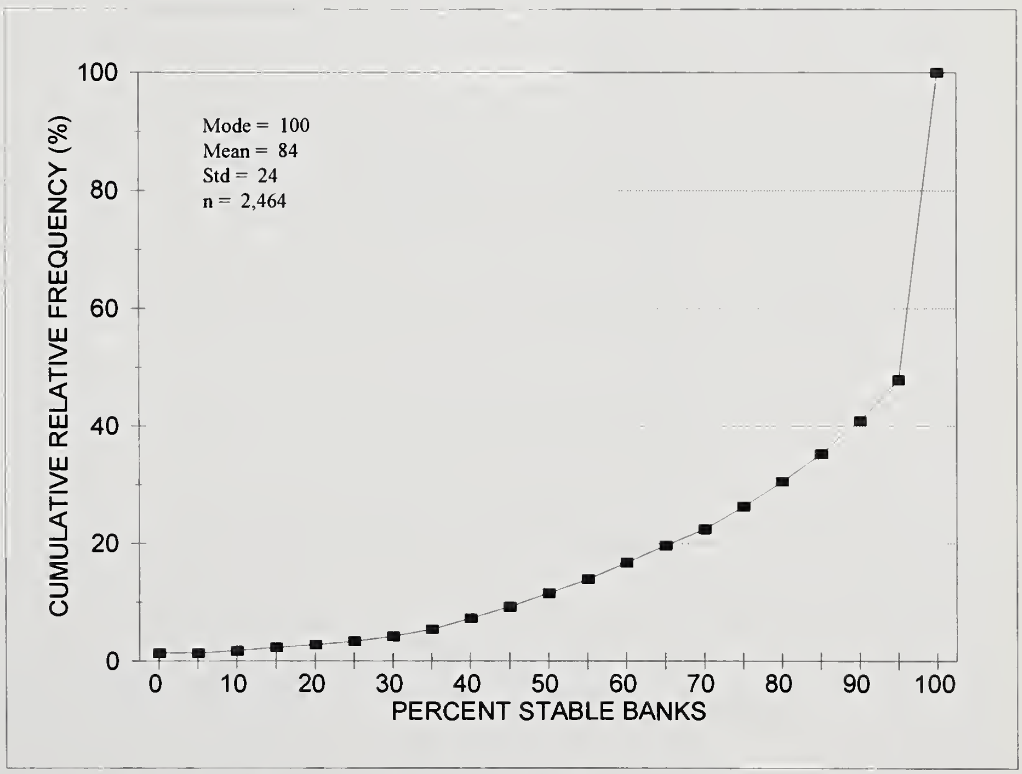

Figure 13—An example cumulative relative frequency distribution for a selected habitat variable—bank stability.

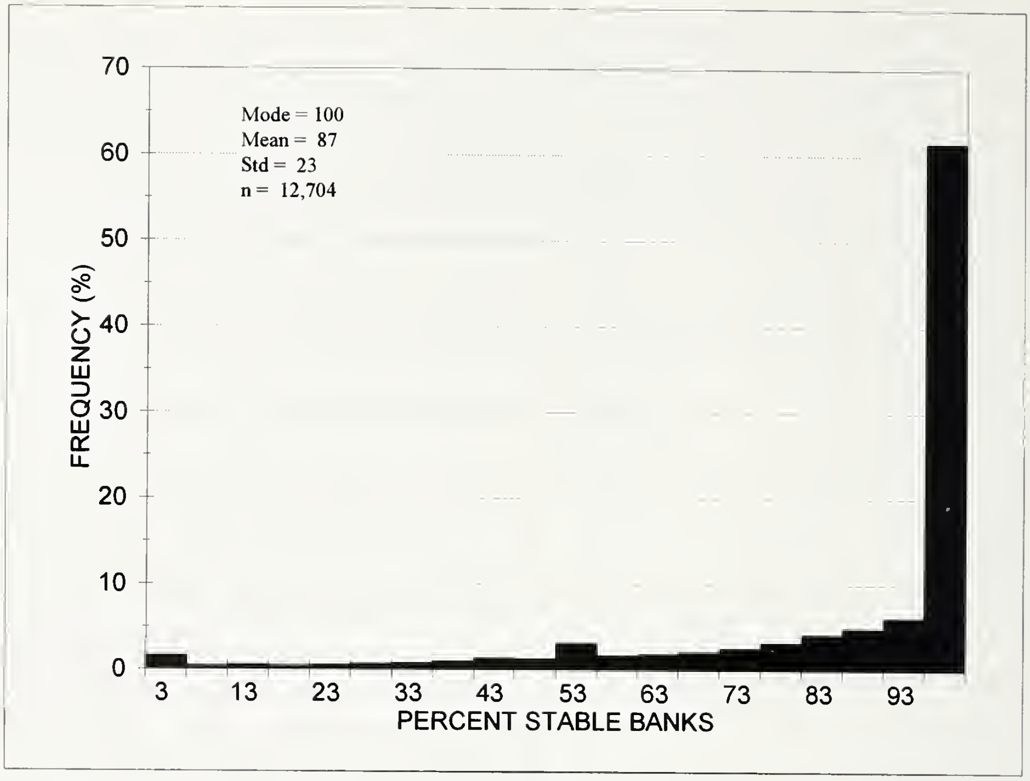

Figure 14—Frequency distribution displaying the range of percent bank stability for all channel reach types.

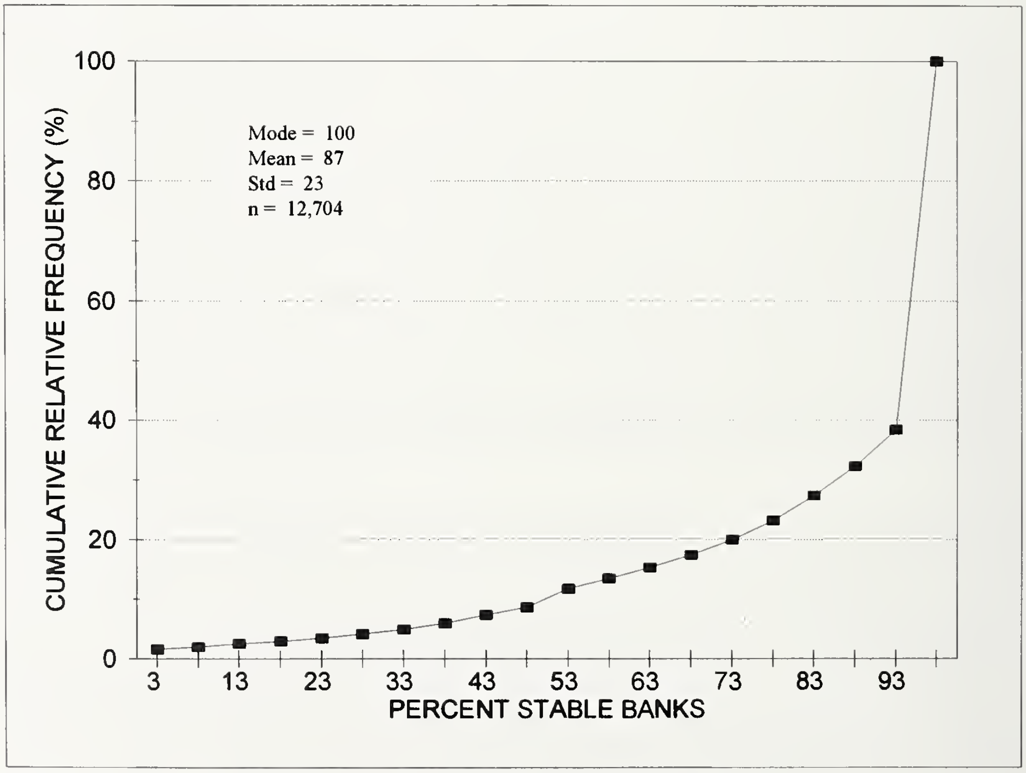

Figure 15—Cumulative relative frequency distribution displaying the range of percent bank stability for all channel reach types.

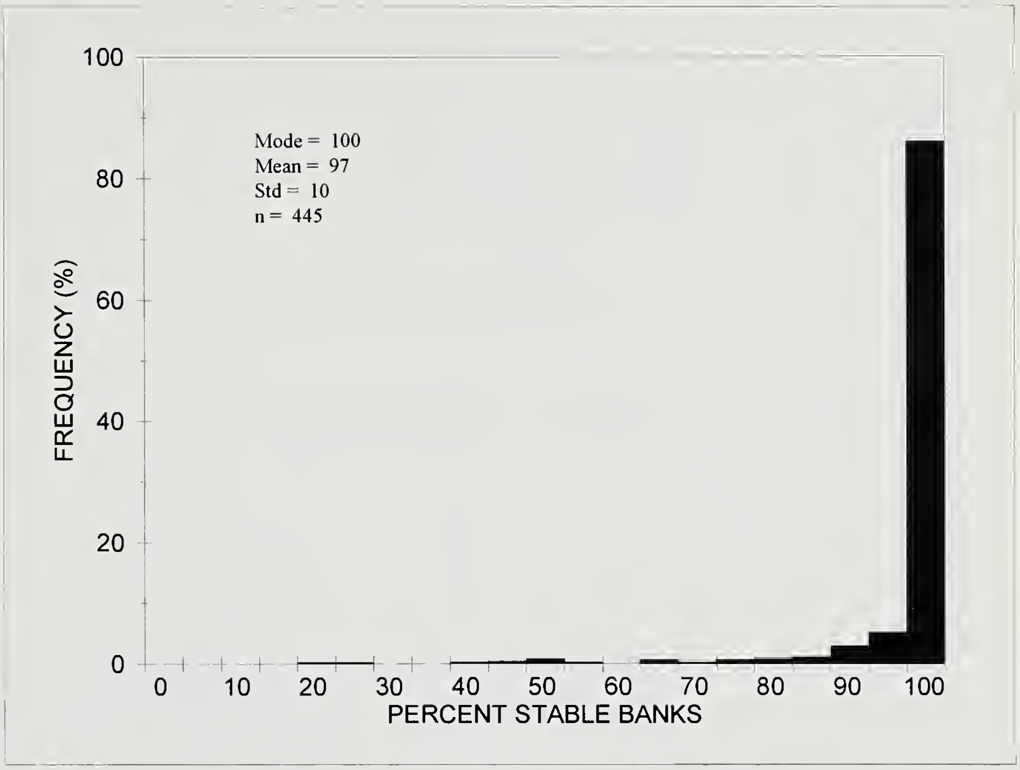

Figure 16—Frequency distribution displaying the range of percent bank stability for "A" channel reach types.

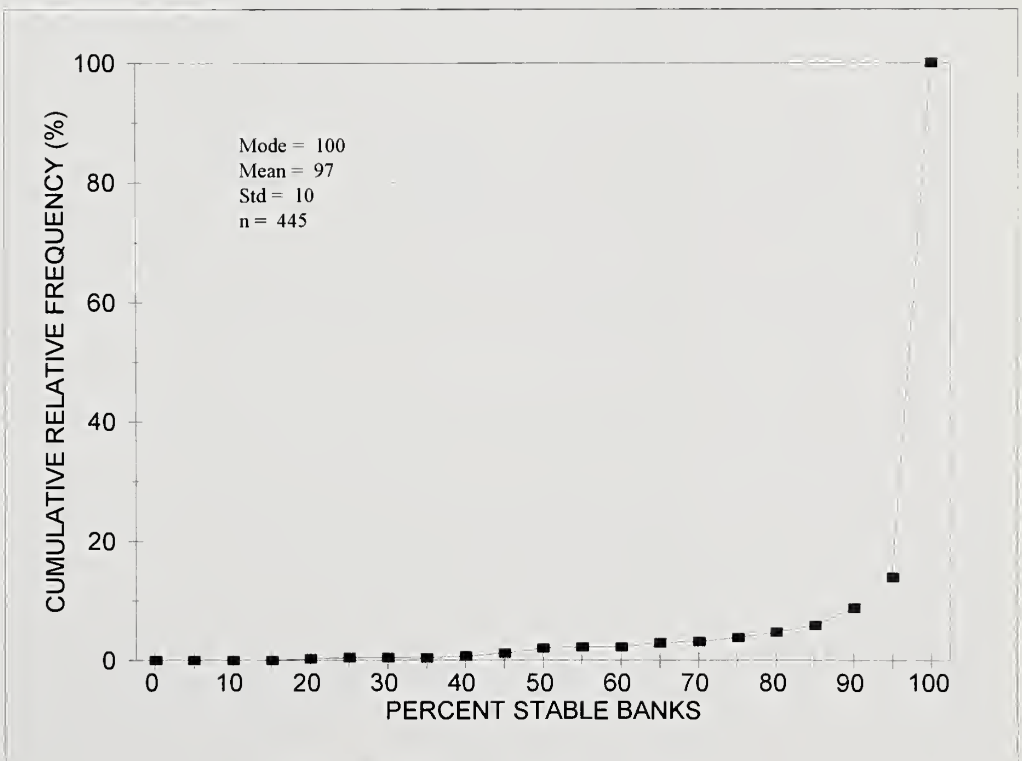

Figure 17—Cumulative relative frequency distribution displaying the range of percent bank stability for "A" channel reach types.

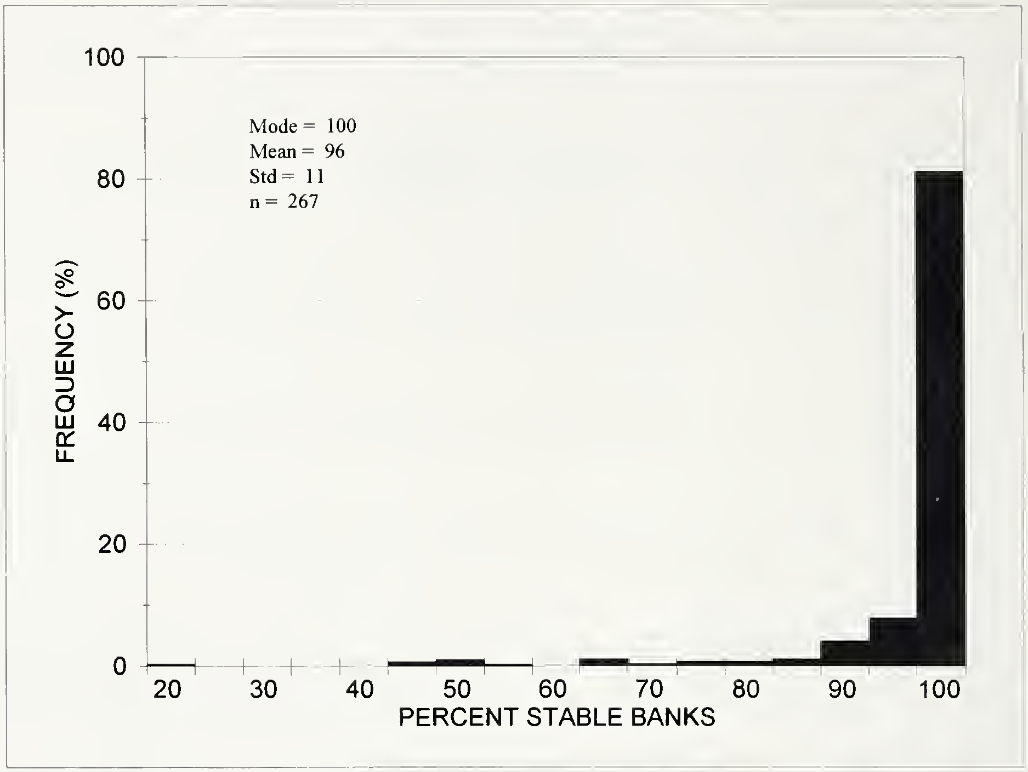

Figure 18—Frequency distribution displaying the range of percent bank stability for "A" channel plutonic stream reaches.

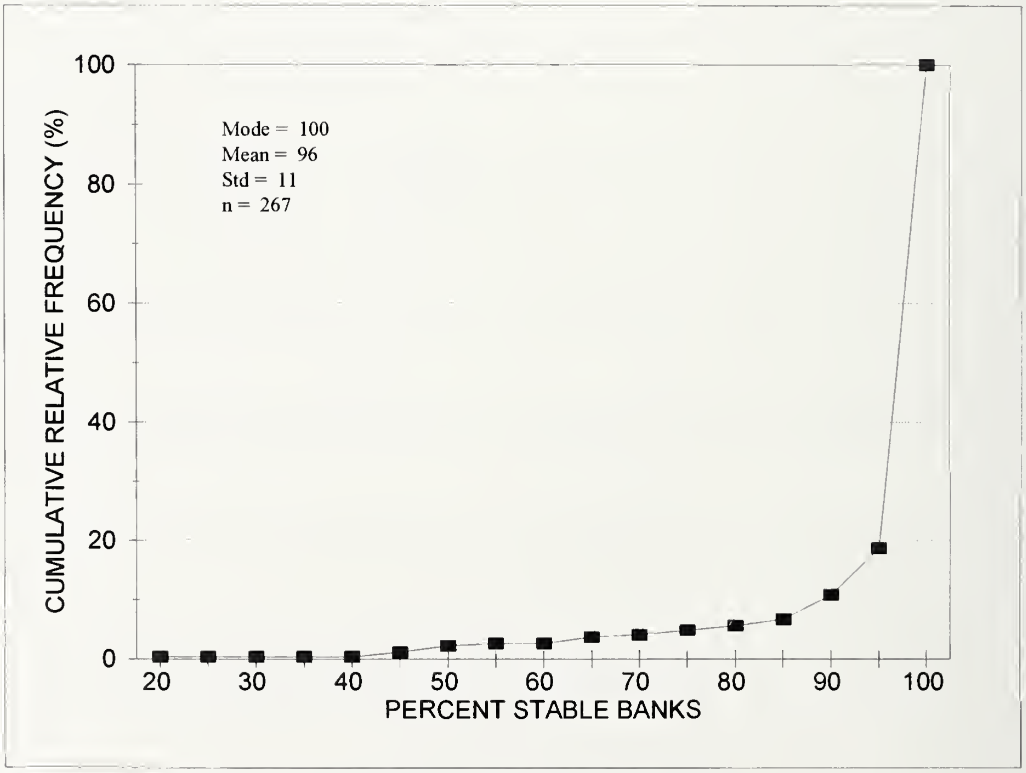

Figure 19—Cumulative relative frequency distribution displaying the range of percent bank stability for "A" channel plutonic stream reaches.

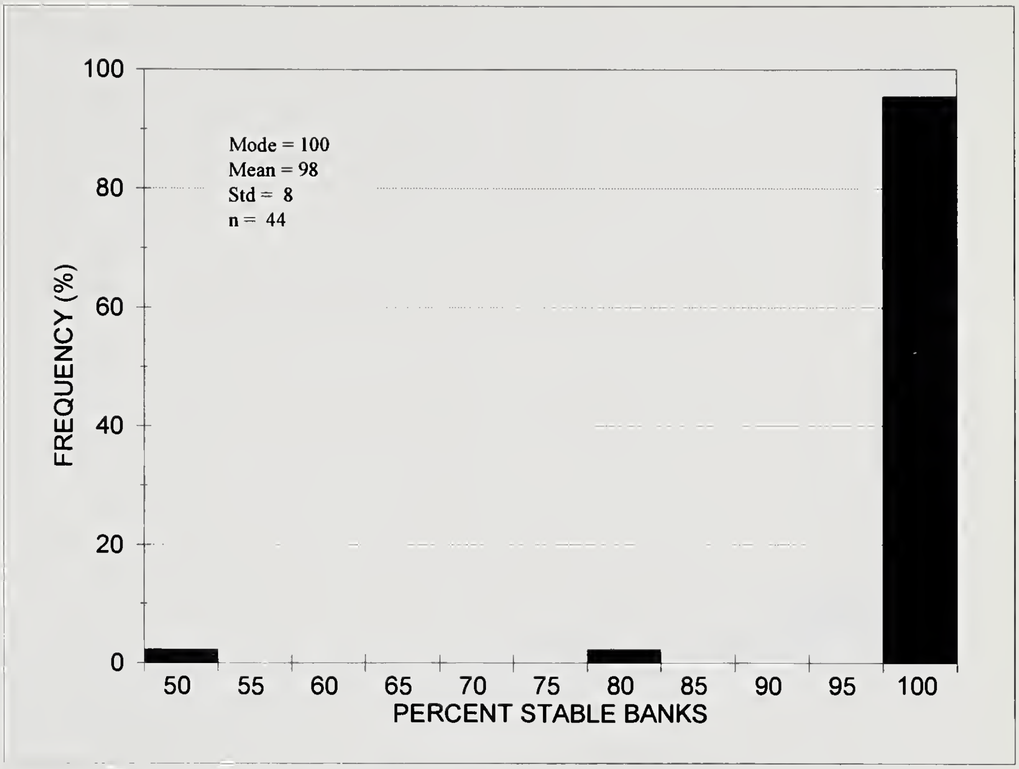

Figure 20—Frequency distribution displaying the range of percent bank stability for "A" channel volcanic stream reaches.

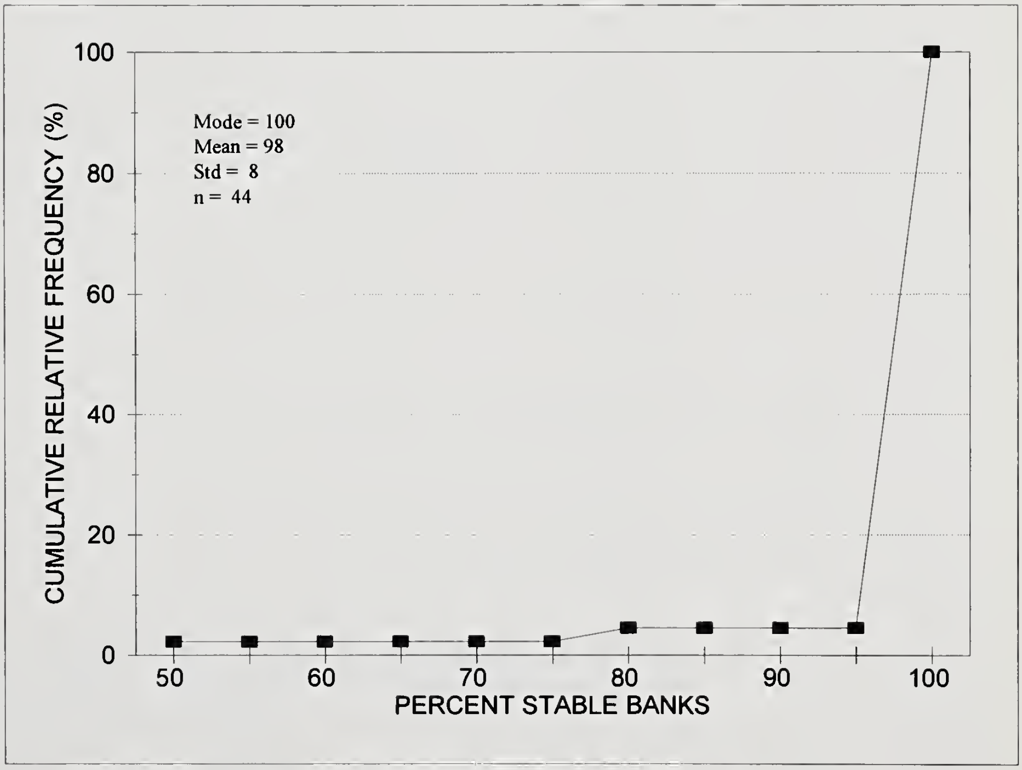

Figure 21—Cumulative relative frequency distribution displaying the range of percent bank stability for "A" channel volcanic stream reaches.

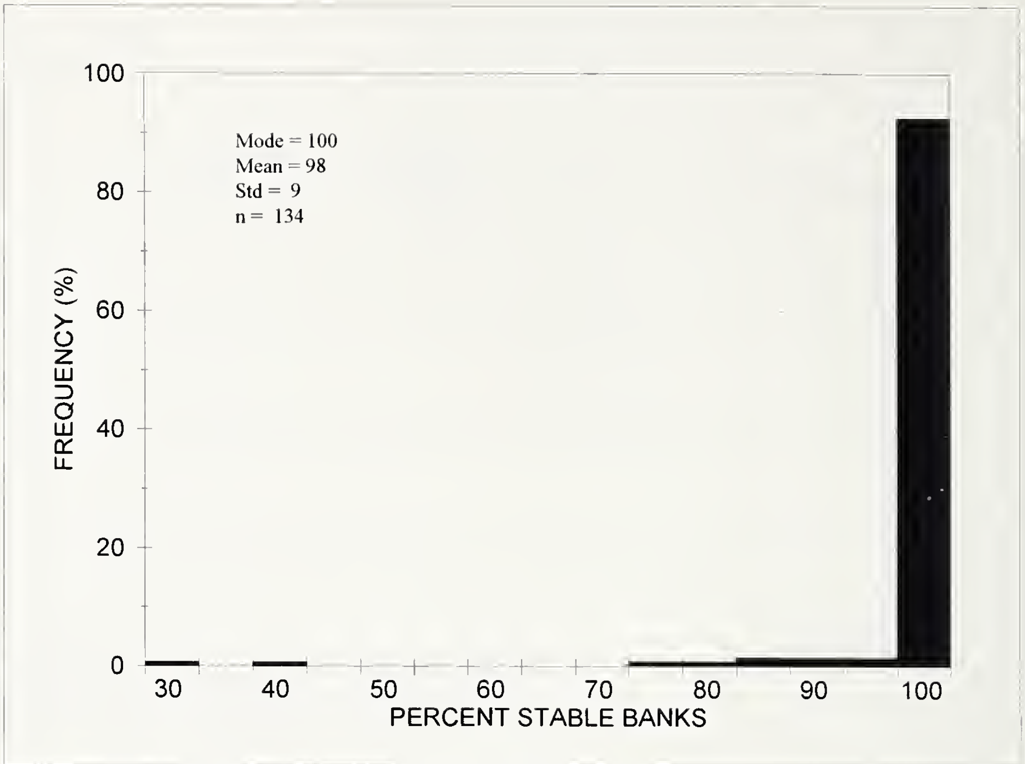

Figure 22—Frequency distribution displaying the range of percent bank stability for "A" channel metamorphic stream reaches.

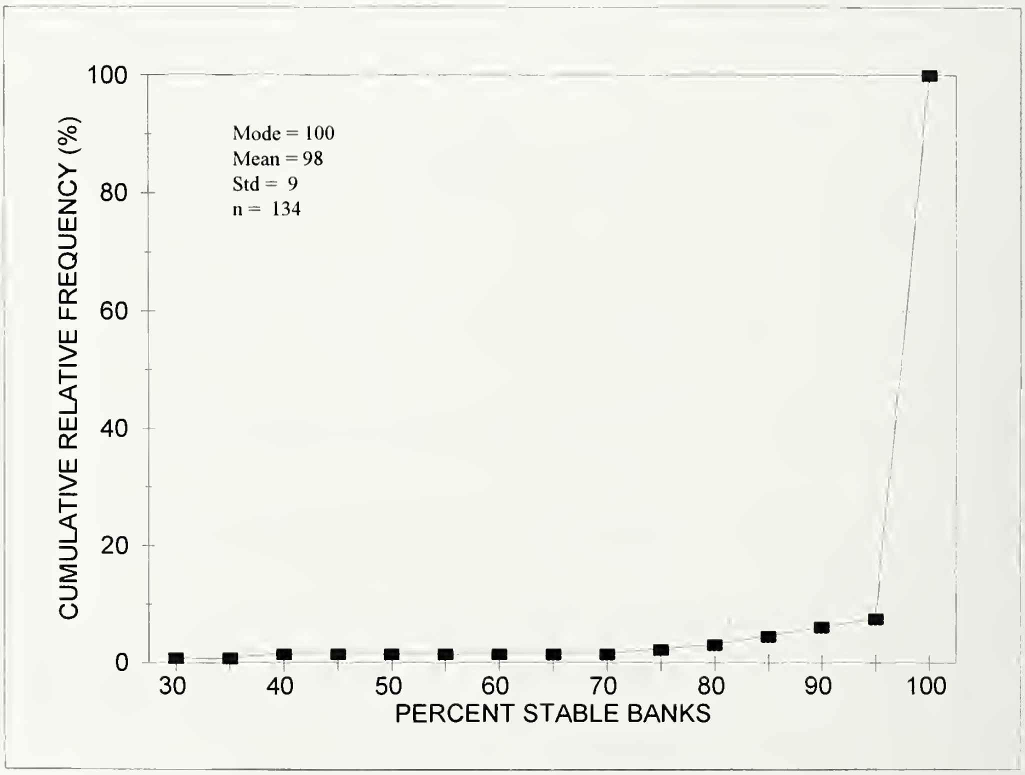

Figure 23—Cumulative relative frequency distribution displaying the range of percent bank stability for "A" channel metamorphic stream reaches.

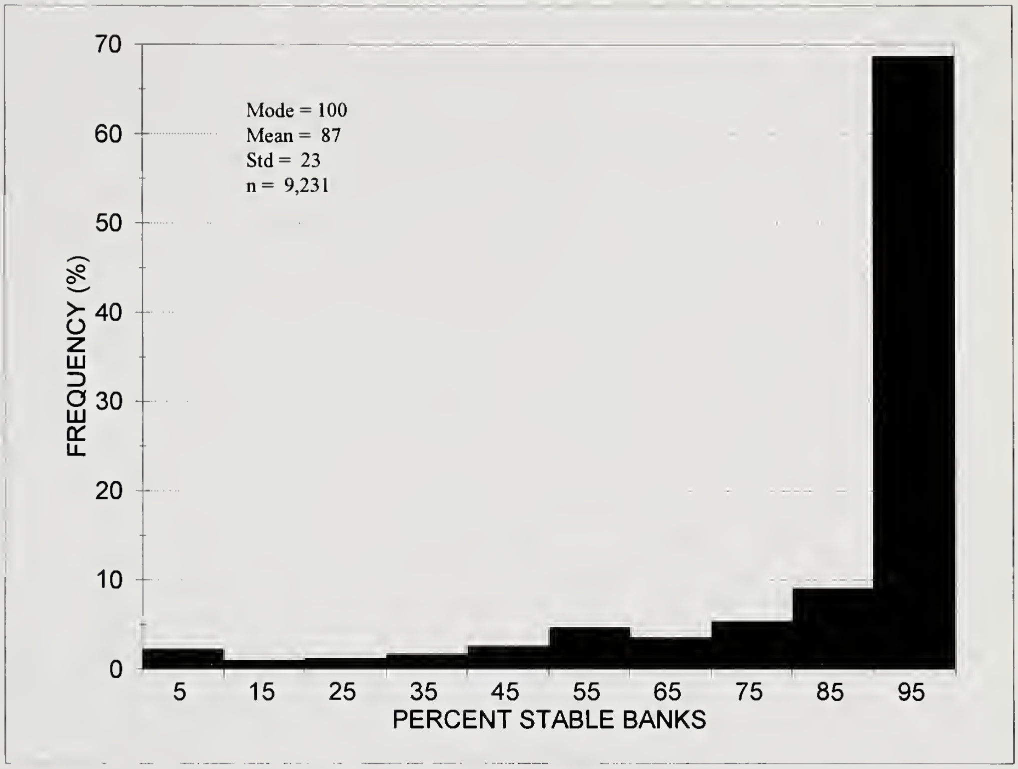

Figure 24—Frequency distribution displaying the range of percent bank stability for "B" channel reach types.

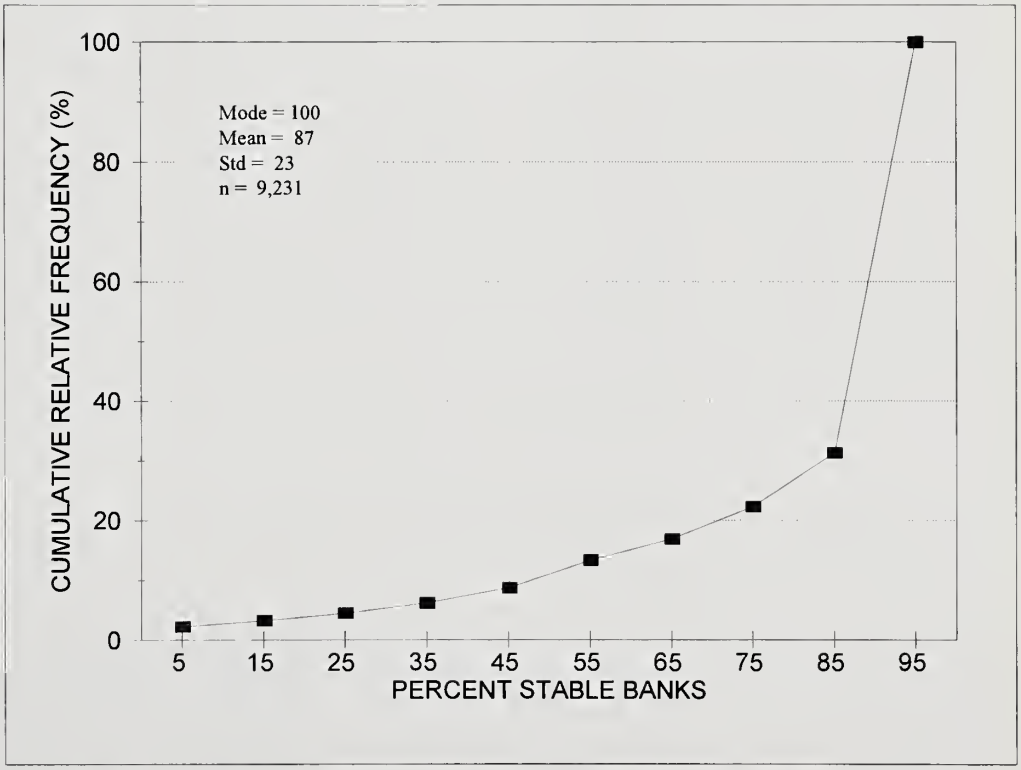

Figure 25—Cumulative relative frequency distribution displaying the range of percent bank stability for "B" channel reach types.

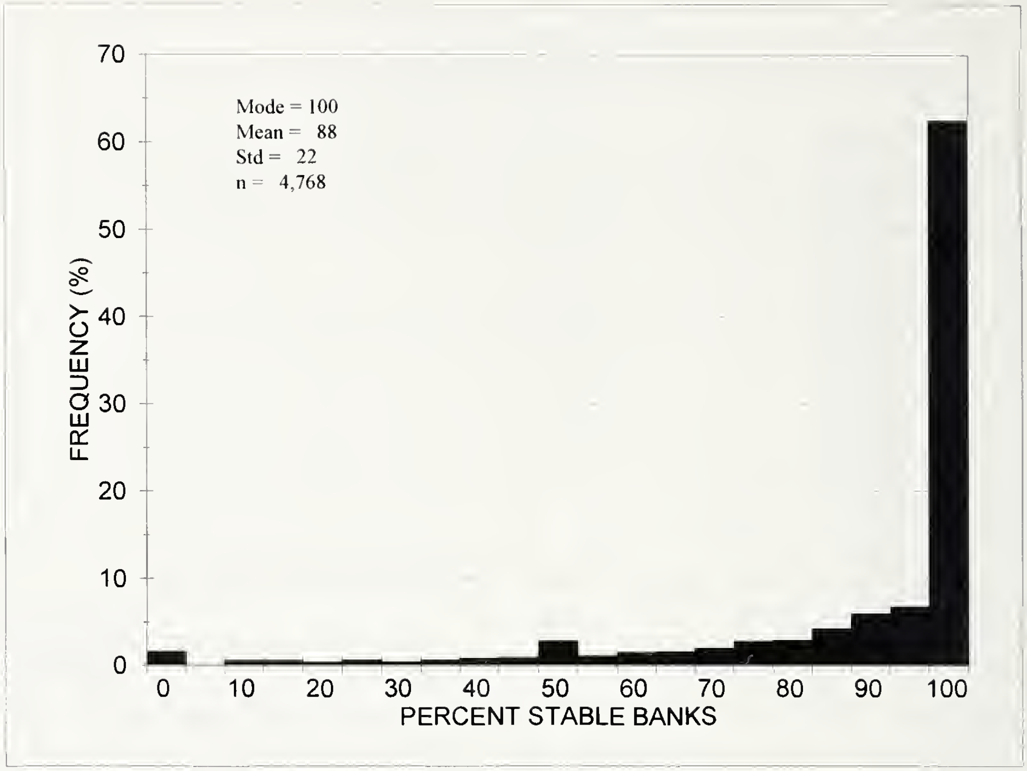

Figure 26—Frequency distribution displaying the range of percent bank stability for "B" channel plutonic stream reaches.

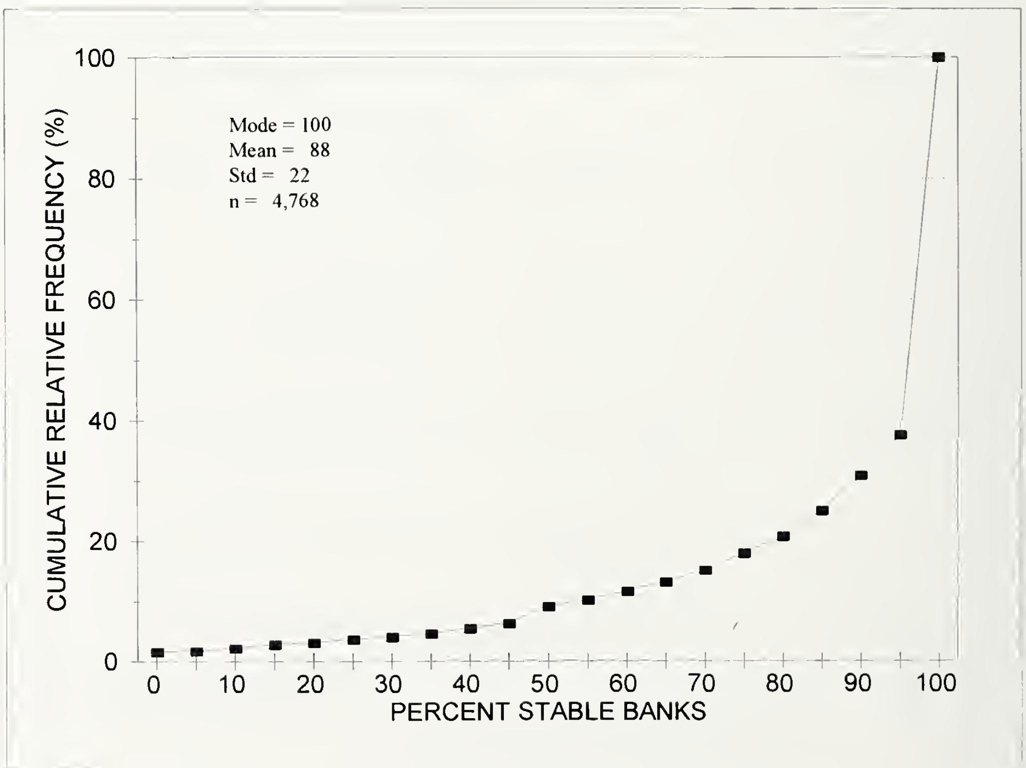

Figure 27—Cumulative relative frequency distribution displaying the range of percent bank stability for "B" channel plutonic stream reaches.

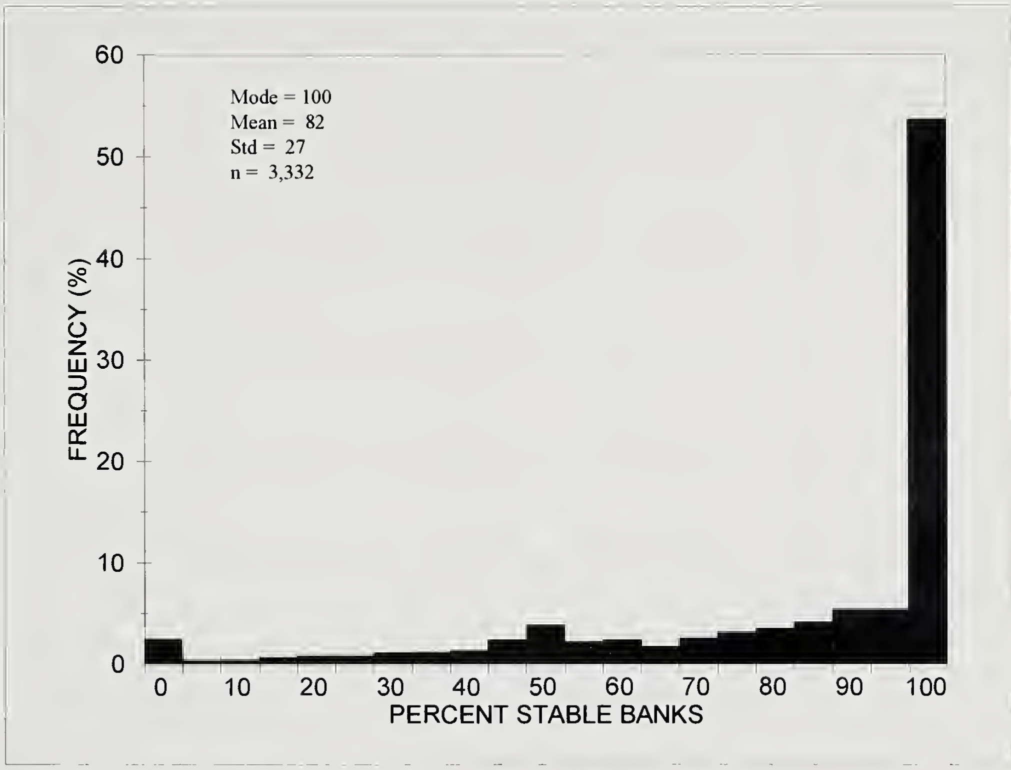

Figure 28—Frequency distribution displaying the range of percent bank stability for "B" channel volcanic stream reaches.

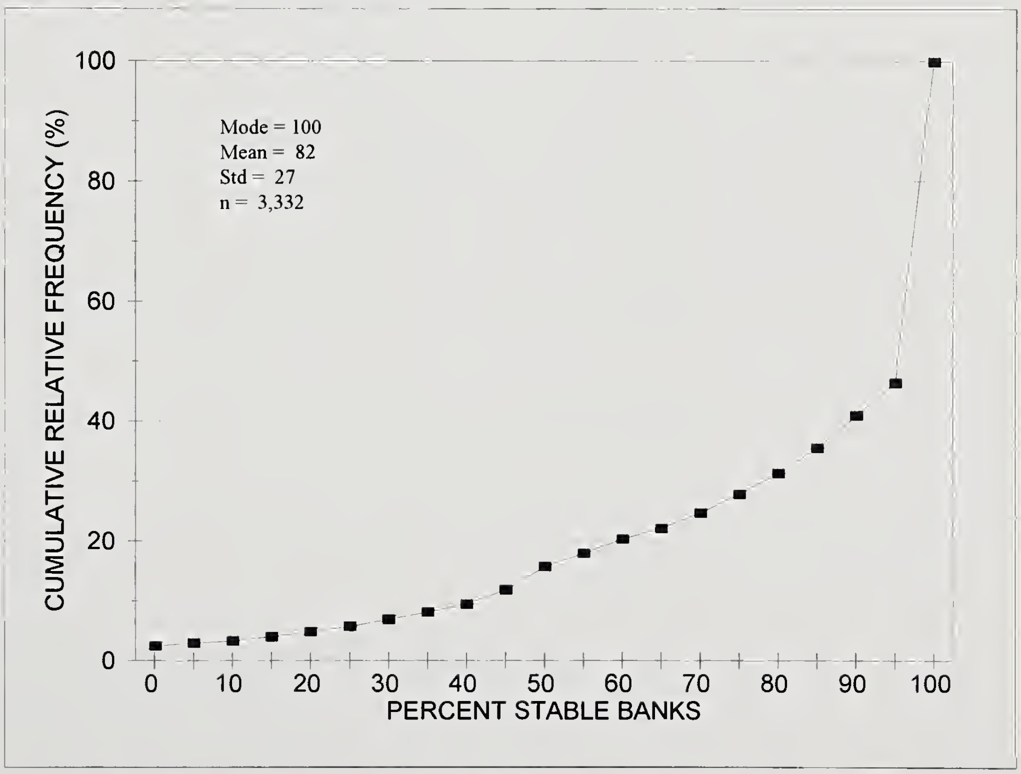

Figure 29—Cumulative relative frequency distribution displaying the range of percent bank stability for "B" channel volcanic stream reaches.

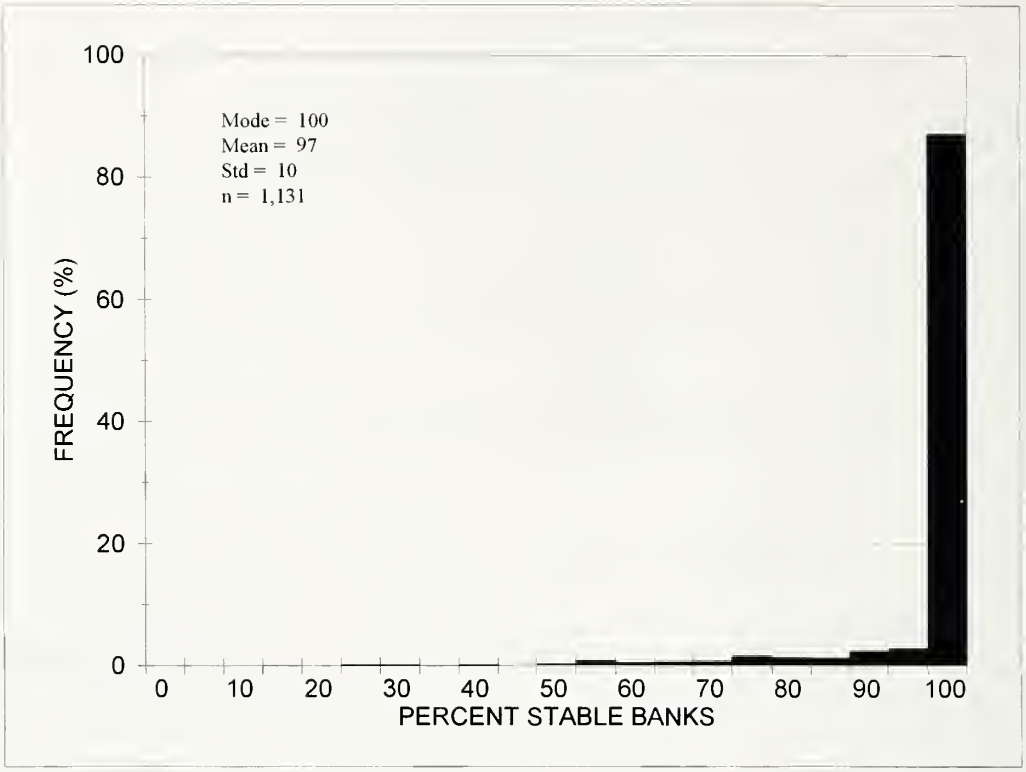

Figure 30—Frequency distribution displaying the range of percent bank stability for "B" channel metamorphic stream reaches.

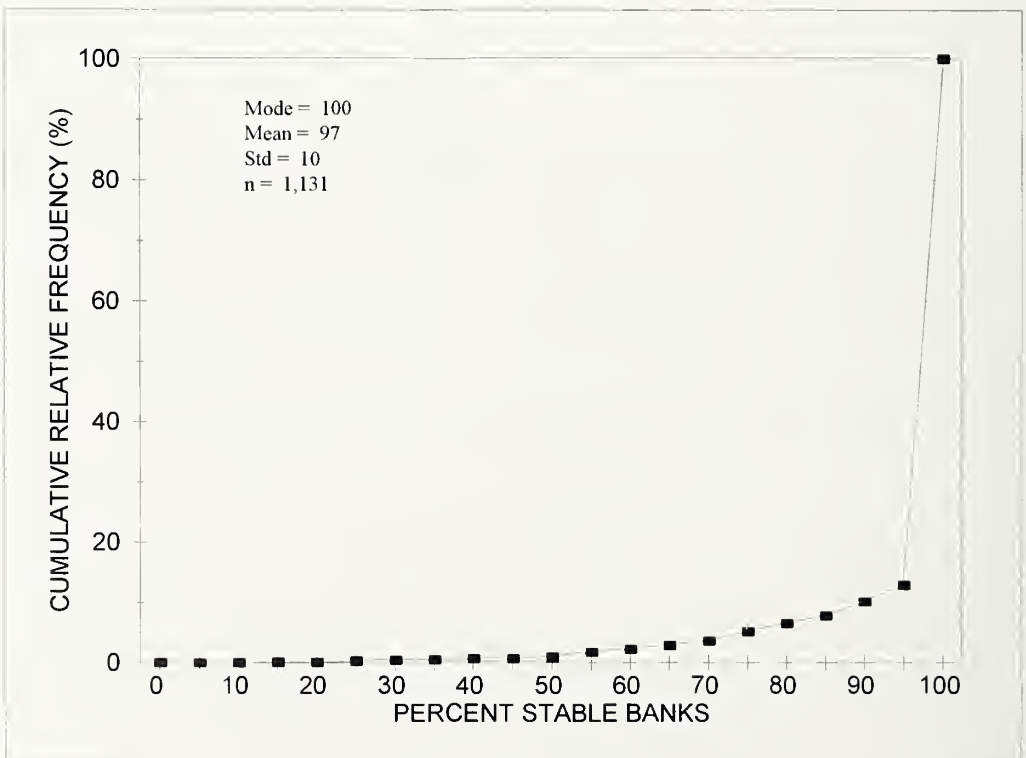

Figure 31—Cumulative relative frequency distribution displaying the range of percent bank stability for "B" channel metamorphic stream reaches.

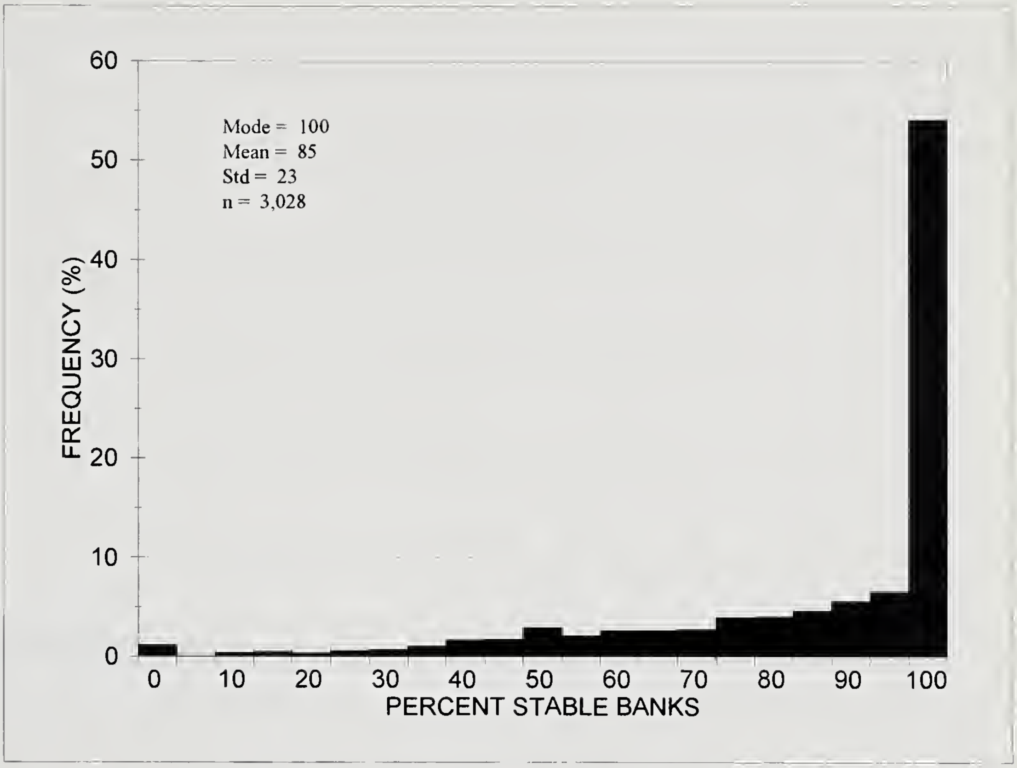

Figure 32—Frequency distribution displaying the range of percent bank stability for "C" channel reach types.

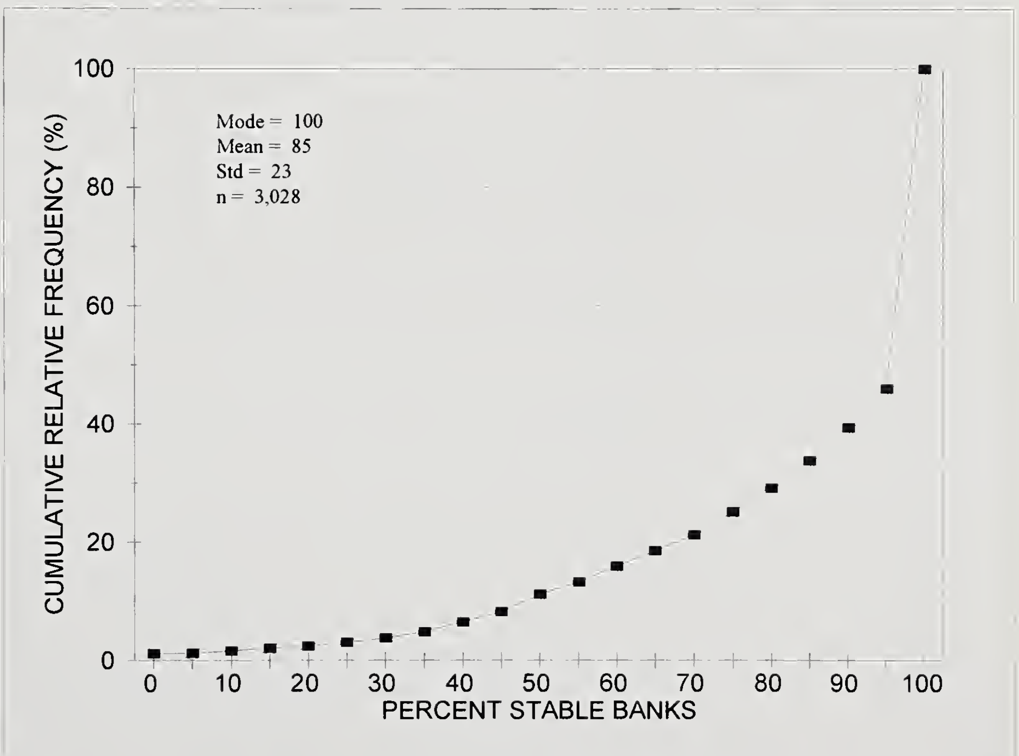

Figure 33—Cumulative relative frequency distribution displaying the range of percent bank stability for "C" channel reach types.

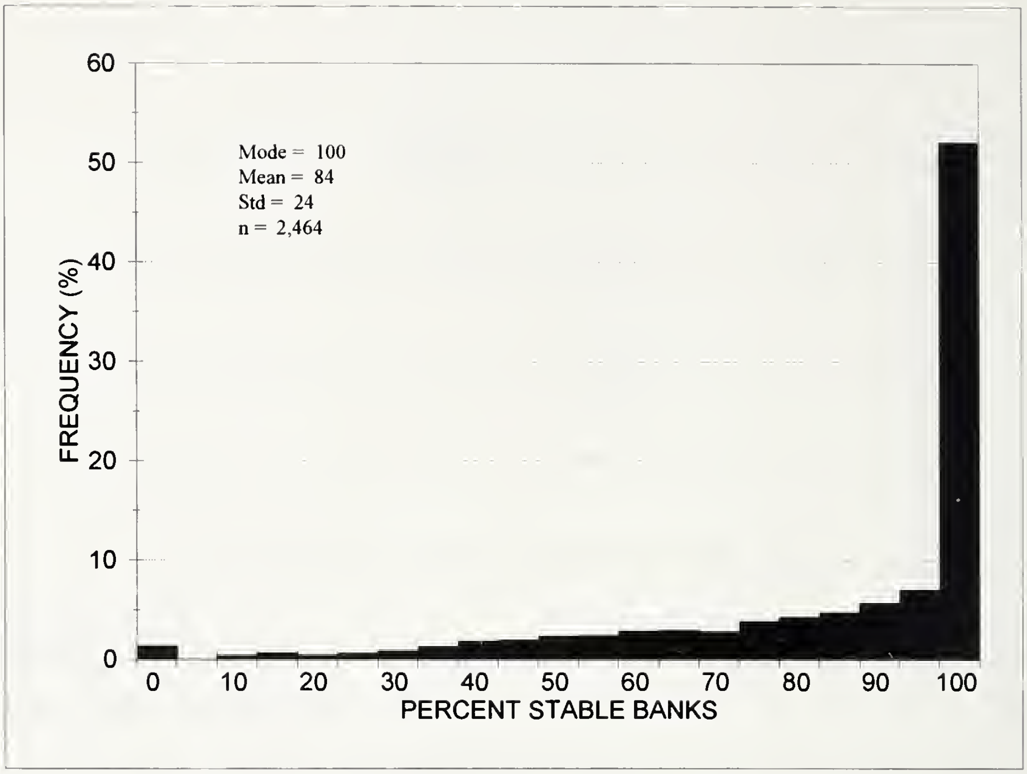

Figure 34—Frequency distribution displaying the range of percent bank stability for "C" channel plutonic stream reaches.

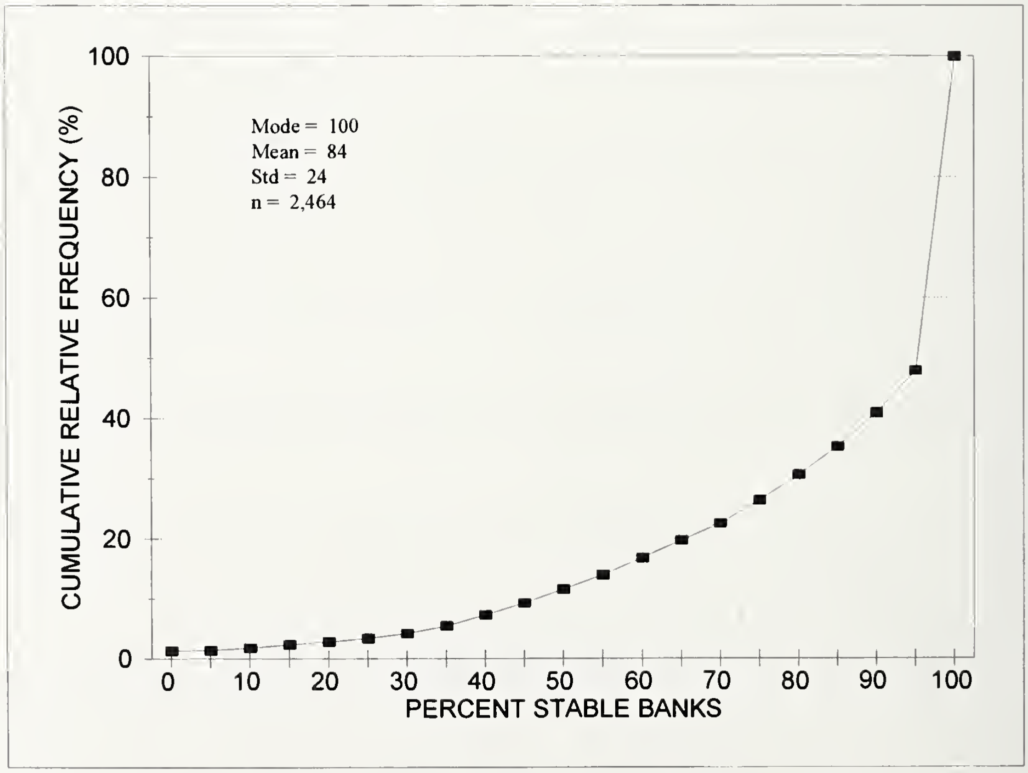

Figure 35—Cumulative relative frequency distribution displaying the range of percent bank stability for "C" channel plutonic stream reaches.

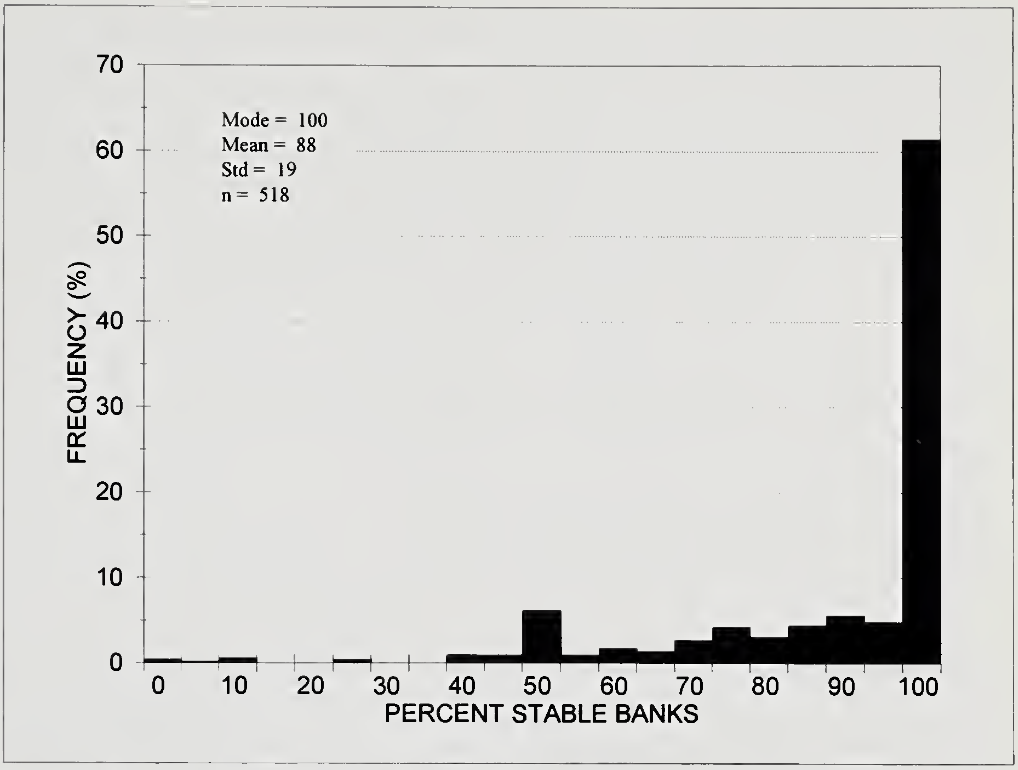

Figure 36—Frequency distribution displaying the range of percent bank stability for "C" channel volcanic stream reaches.

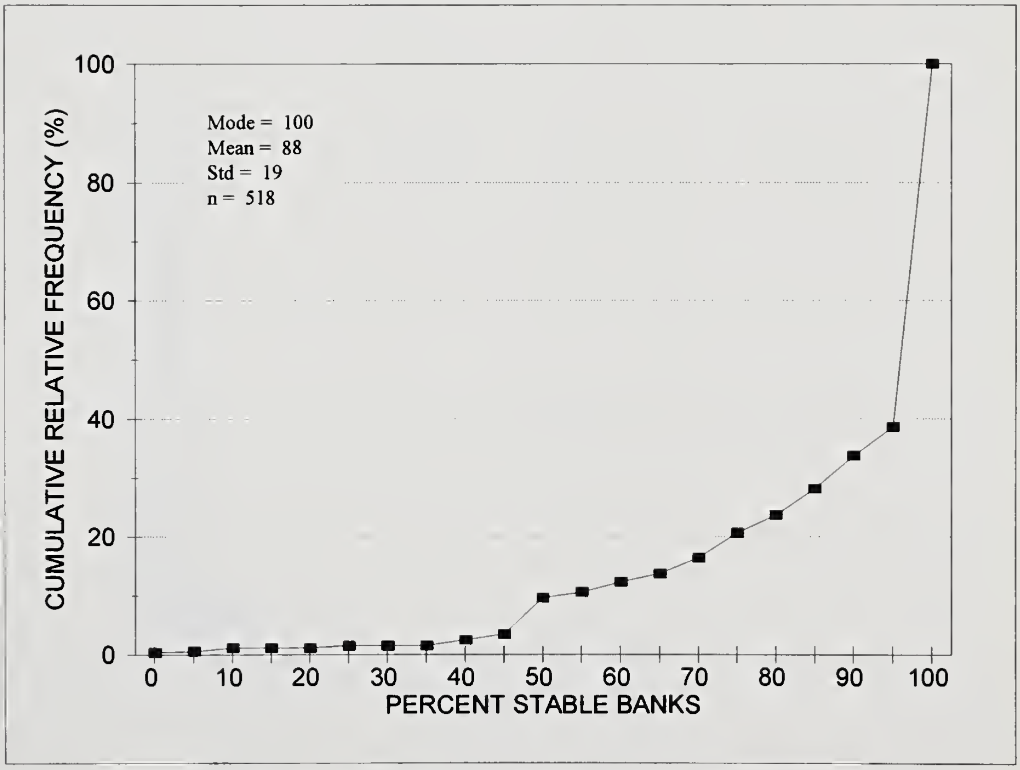

Figure 37—Cumulative relative frequency distribution displaying the range of percent bank stability for "C" channel volcanic stream reaches.

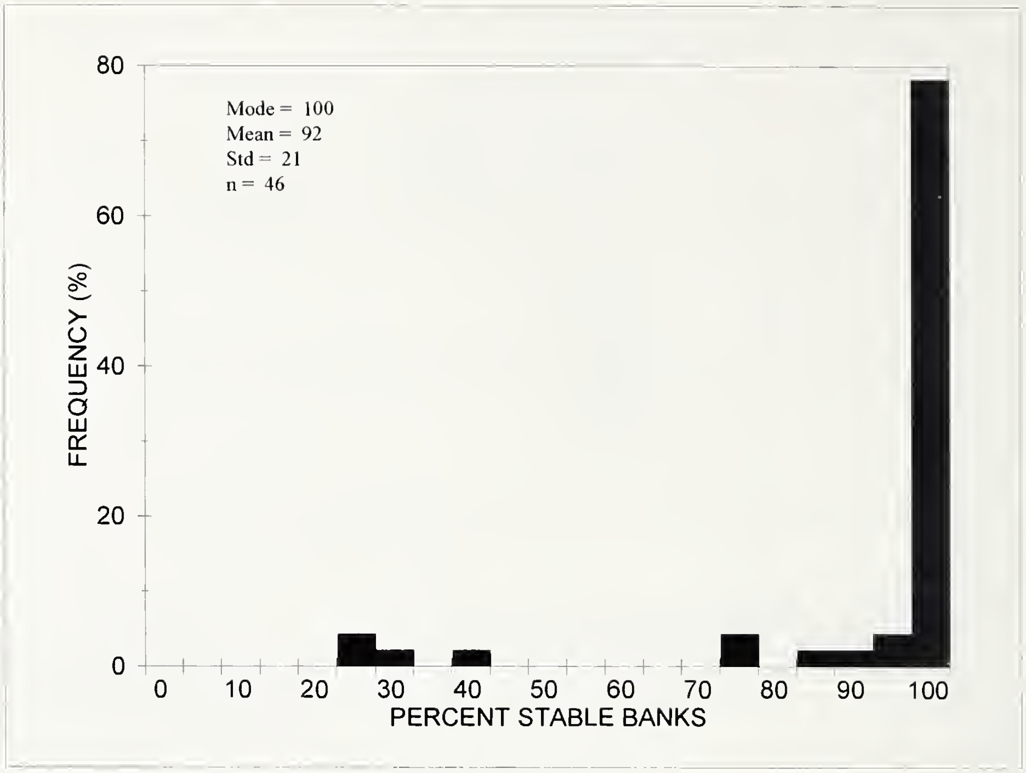

Figure 38—Frequency distribution displaying the range of percent bank stability for "C" channel sedimentary stream reaches.

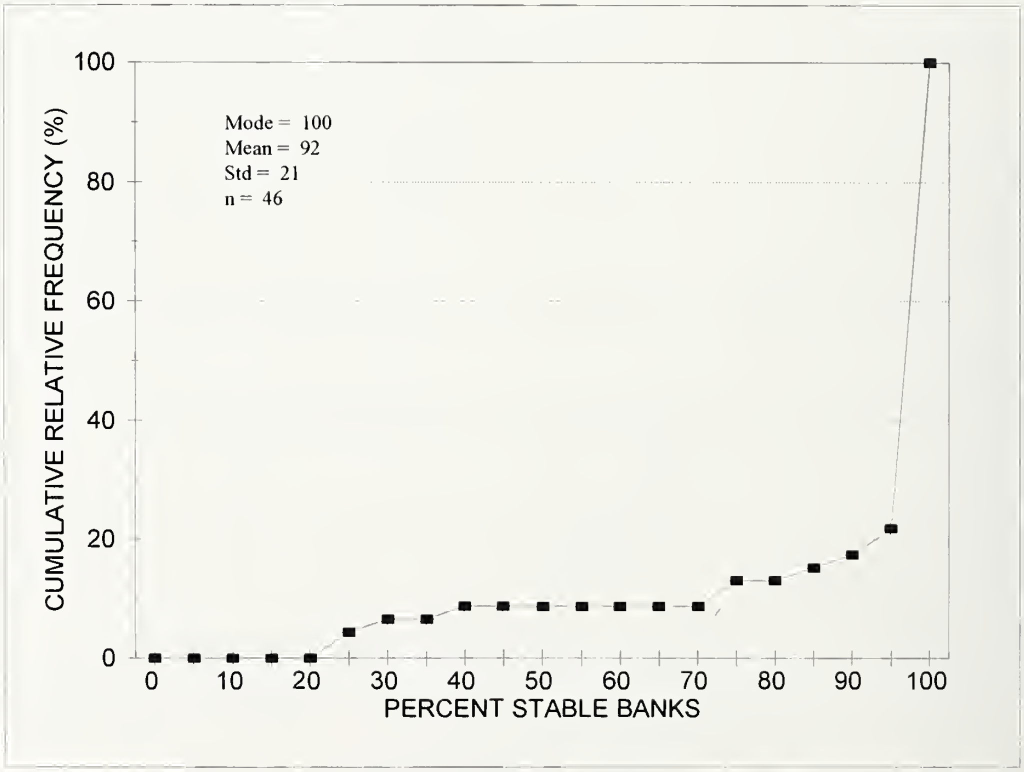

Figure 39—Cumulative relative frequency distribution displaying the range of percent bank stability for "C" channel sedimentary stream reaches.

Bank Undercut

Percent bank undercut appears to be another potential channel feature to assist in determining the condition of habitat for low gradient (less than 1.5 percent), unconfined, "C" channel reach types. Bank undercut provides important cover for salmonids. Undercut is a primary reflection of bank vegetation and bank soil composition. Vigorous bank vegetation with well-developed root mass holds overhanging banks together as bank soils are eroded, leaving a root-armoured cavity. The overhang and usage of roots provide predatory escape cover for juvenile and adult fish while trapping and storing organics and macroinvertebrates for fish food.

Percent bank undercut is expected to be highly variable, more so than bank stability. Dry, lower elevation sites and fine-grained bank material, although within the same channel reach type, are not conducive to the formation of bank undercuts. Wide, shallow channels are common where coarse sand and a lack of vegetation provides little resistance to lateral erosion (Schumm 1960). Bank vegetation may increase bank resistance, allowing formation of meander patterns similar to high salt/clay banks (Mackin 1956). Figures 40 through 47 are the statistical summaries for percent bank undercut for "C" channel reach types grouped by geology.

Temperature

Stream temperatures reflect both the seasonal change in net radiation and daily changes in air temperature. Flow velocity, shading, instream cover, flow depth, and ground water inflow affect temperature. Water temperatures influence the metabolism, behavior, and mortality of fish (Mihursky and Kennedy 1967). Increased water temperatures are known to increase biological activity; a 10 °C increase in temperature will double the metabolic

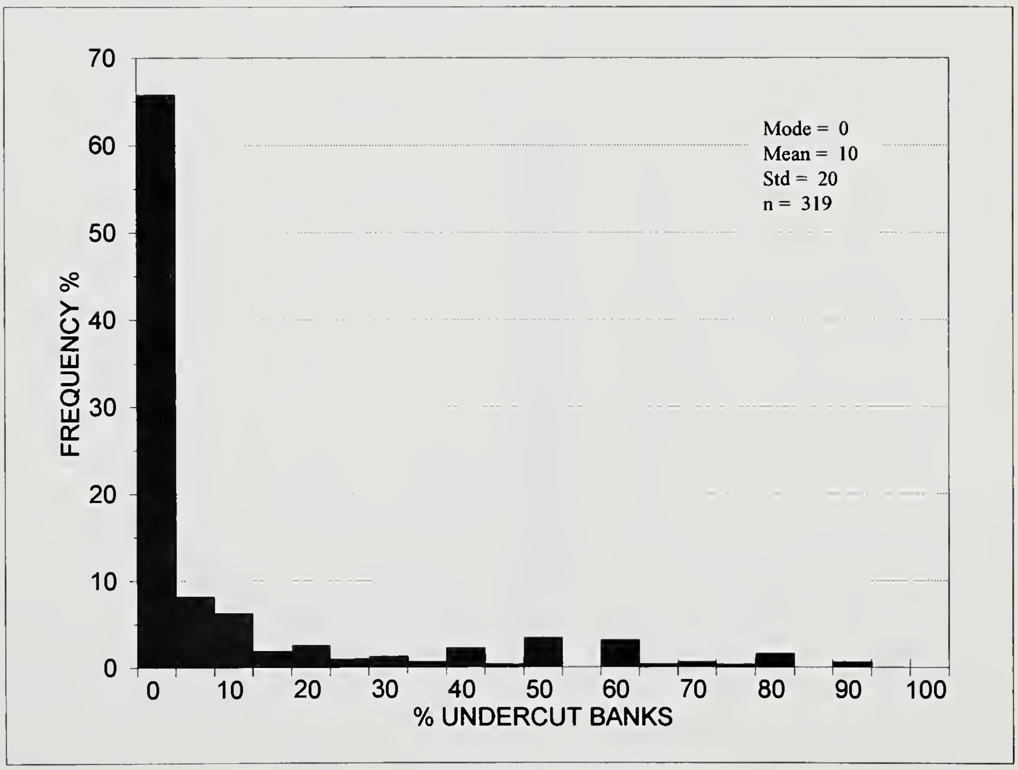

Figure 40—Frequency distribution displaying the range of percent bank undercut for "C" channel reach types.

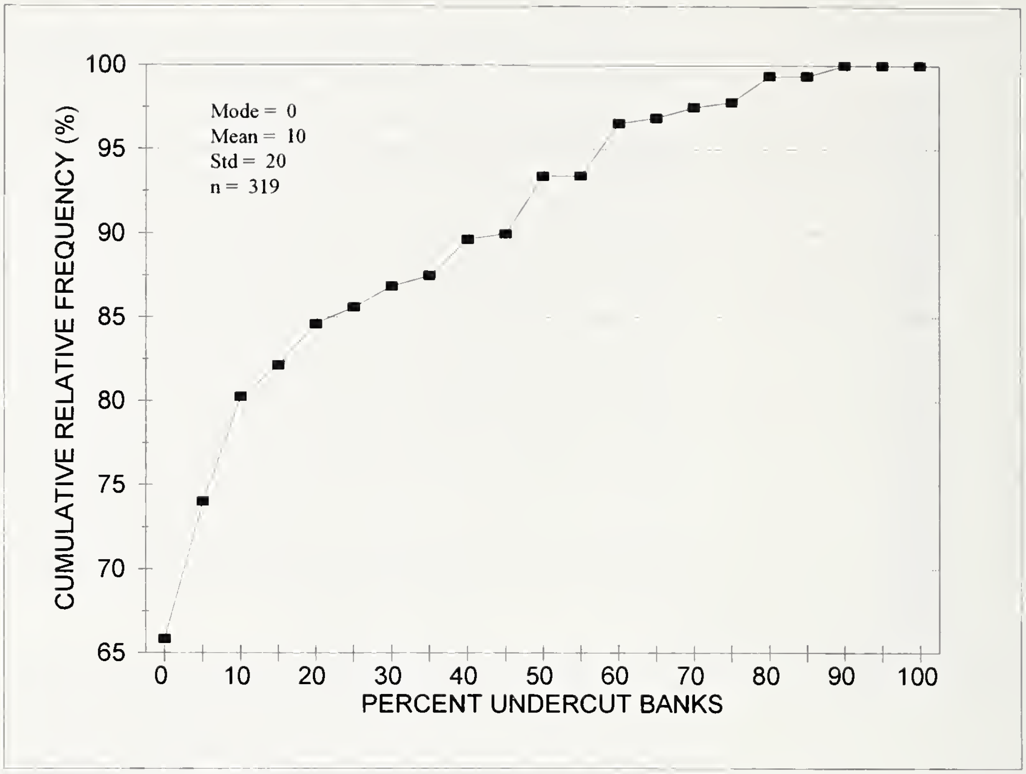

Figure 41—Cumulative relative frequency distribution displaying the range of percent bank undercut for "C" channel reach types.

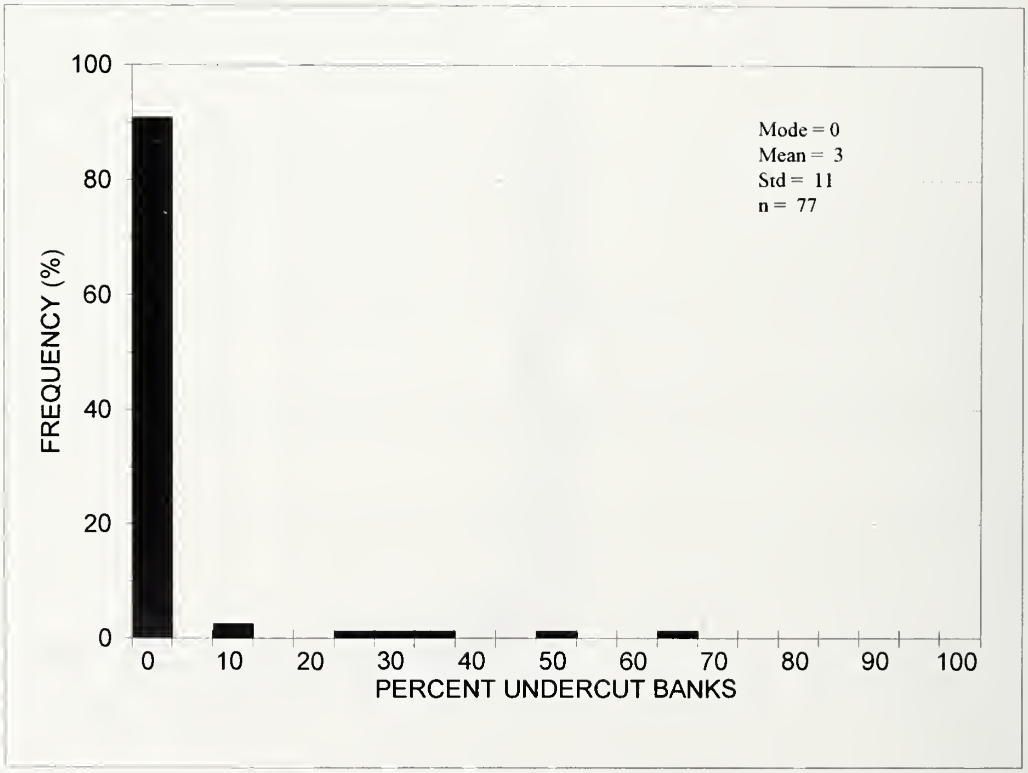

Figure 42—Frequency distribution displaying the range of percent bank undercut for "C" channel plutonic stream reaches.

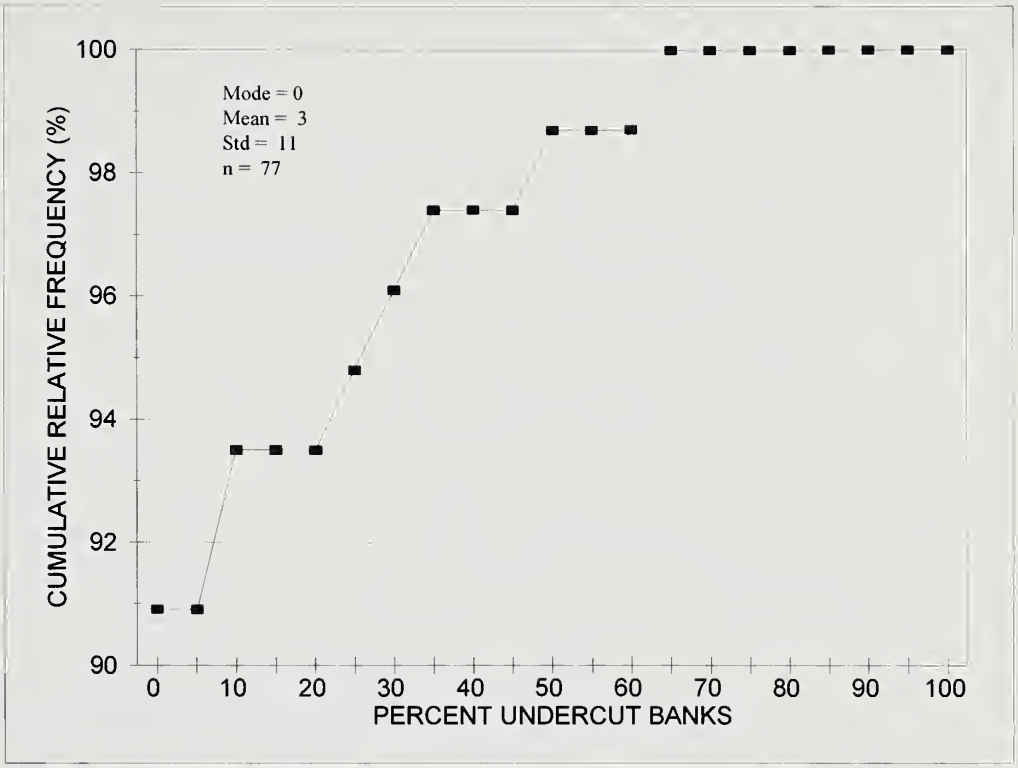

Figure 43—Cumulative relative frequency distribution displaying the range of percent bank undercut for "C" channel plutonic stream reaches.

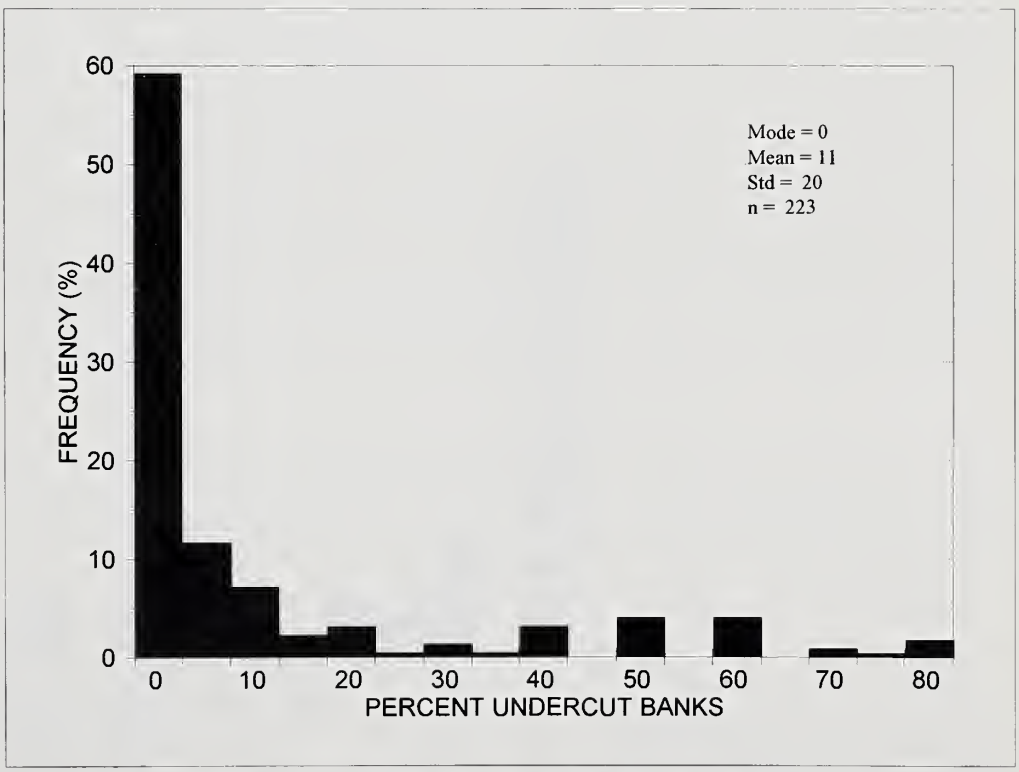

Figure 44—Frequency distribution displaying the range of percent bank undercut for "C" channel volcanic stream reaches.

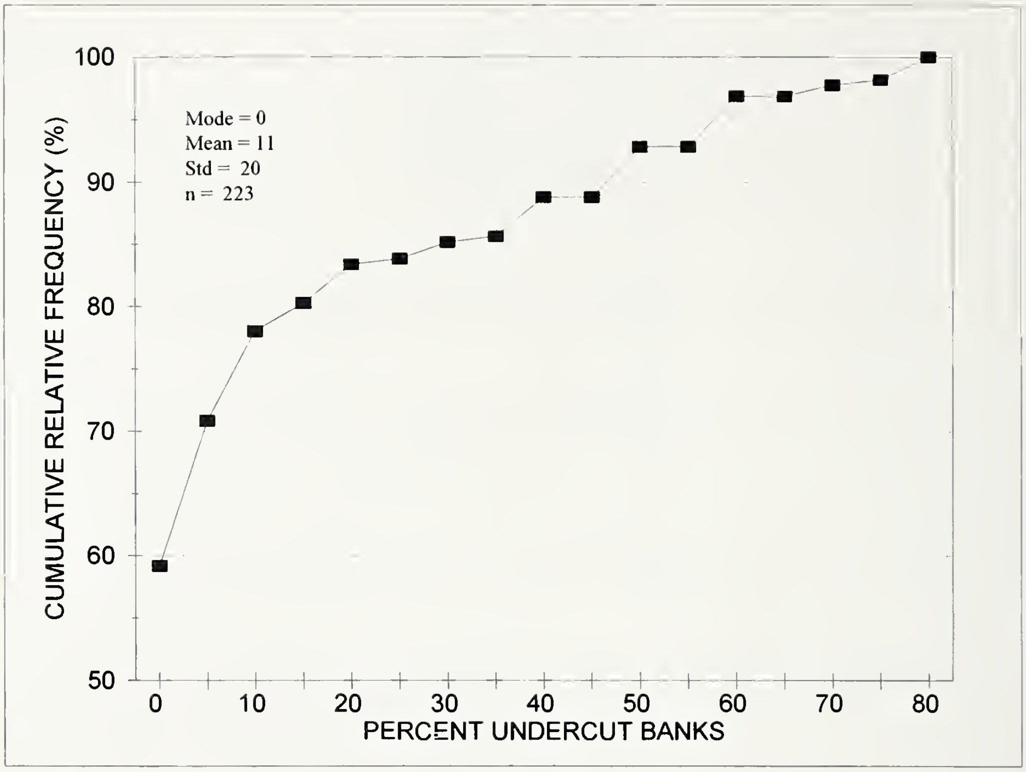

Figure 45—Cumulative relative frequency distribution displaying the range of percent bank undercut for "C" channel volcanic stream reaches.

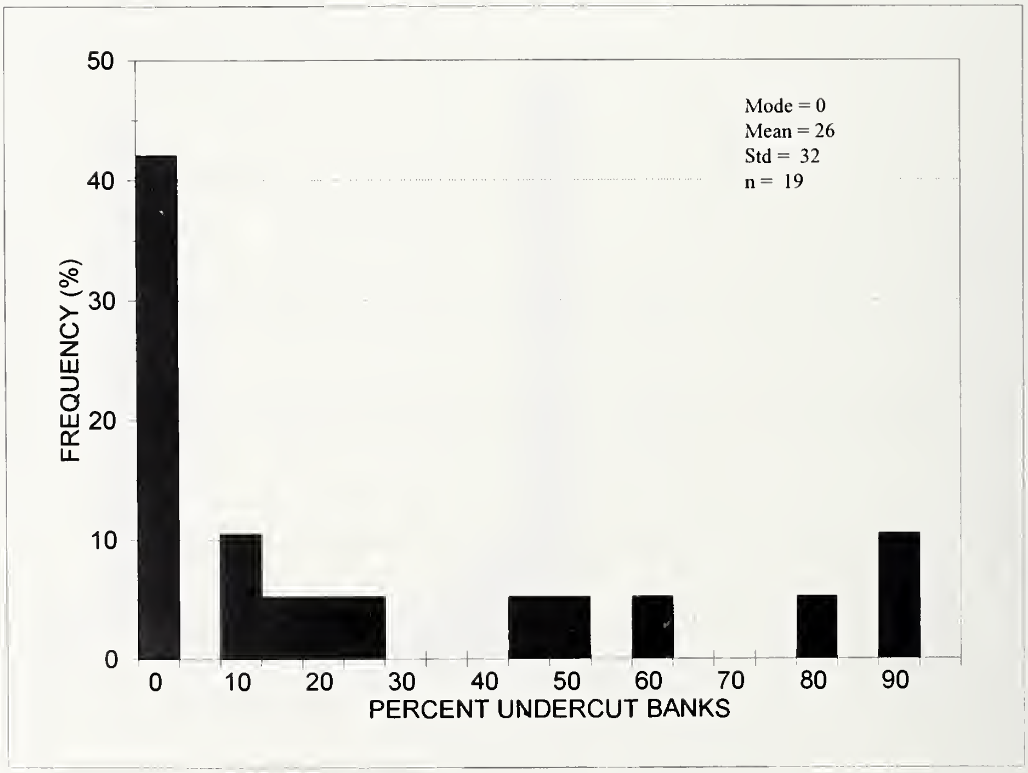

Figure 46—Frequency distribution displaying the range of percent bank undercut for "C" channel sedimentary stream reaches.

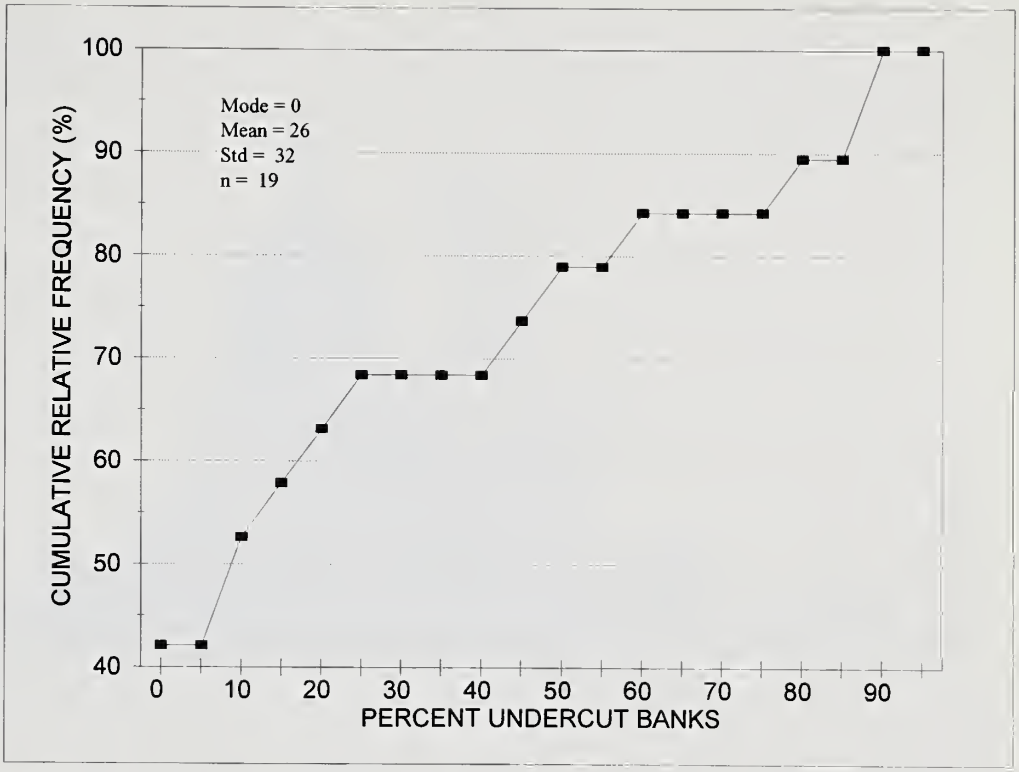

Figure 47—Cumulative relative frequency distribution displaying the range of percent bank undercut for "C" channel sedimentary stream reaches.

rate of cold-blooded organisms. Idaho State Law [16 IDAPA 1-2250(C)] requires that spawning temperatures cannot exceed 13 °C. Table 10 displays experimental temperature response data for juvenile chinook salmon summarized by Armour (1988).

Habitat inventories monitor stream temperatures by taking instantaneous measurements with hand-held thermometers (hand-held thermometers should be calibrated before using because they can vary ±5 °C). Measurements are collected throughout the day (morning, noon, evening) to capture the daily temperature range. Figures 48 through 69 are the statistical summaries for temperature grouped by all surveyed stream reaches, by channel reach types, and by channel reach types and geology.

Table 10—Experimental temperature response data for juvenile chinook salmon (Armour 1988).

Acclimation temperature	Temperature for 50 percent mortality	
°C	*°C*	
	Lower	Upper
5.0	—	21.5
10.0	0.8	24.3
15.0	2.5	25.0
20.0	4.5	25.1
Growth optimum	14.8 (Brett and others 1982)	
Zero net growth	19.1 Upper (Hokanson and Biesinger, unpublished report)	
	4.5 Lower (Hokanson and Biesinger)	
Final preferendum	11.7 (Hokanson and Biesinger)	
Physiological optimum	13.6 (Hokanson and Biesinger)	

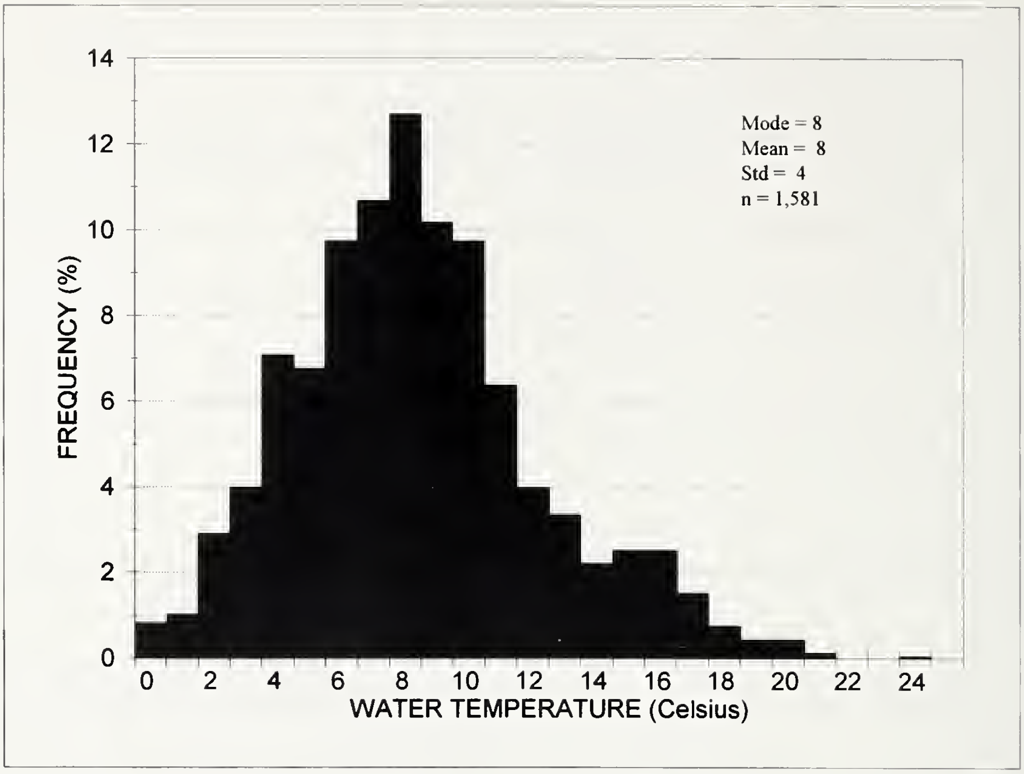

Figure 48—Frequency distribution displaying the range of water temperature for all channel reach types.

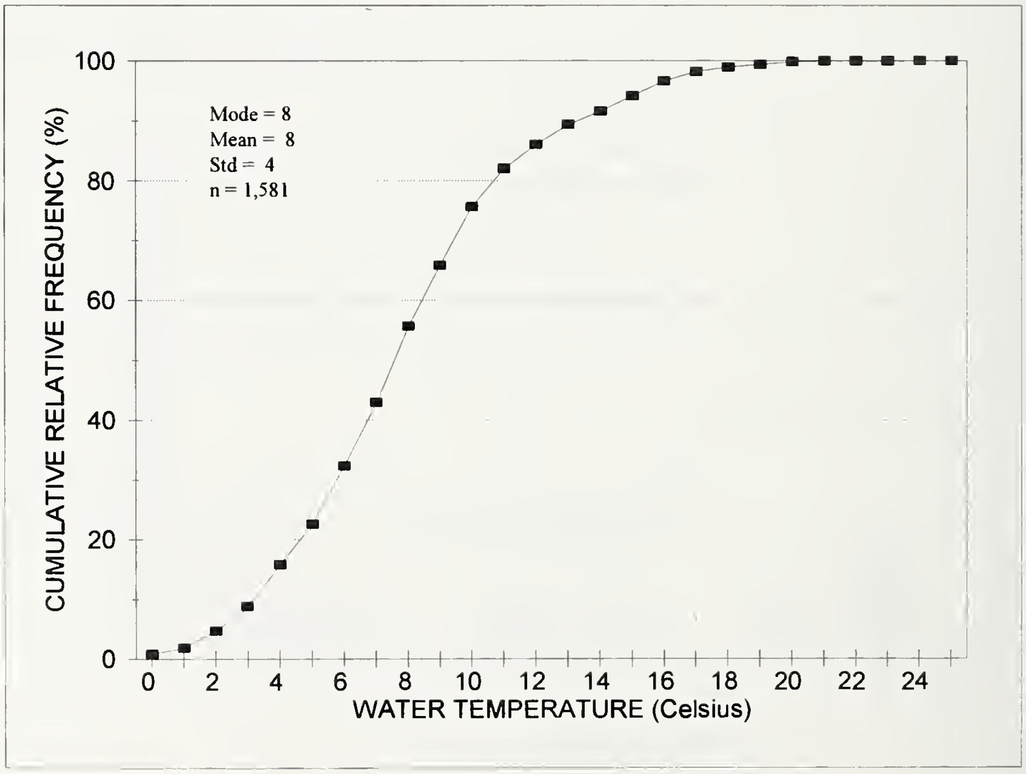

Figure 49—Cumulative relative frequency distribution displaying the range of water temperature for all channel reach types.

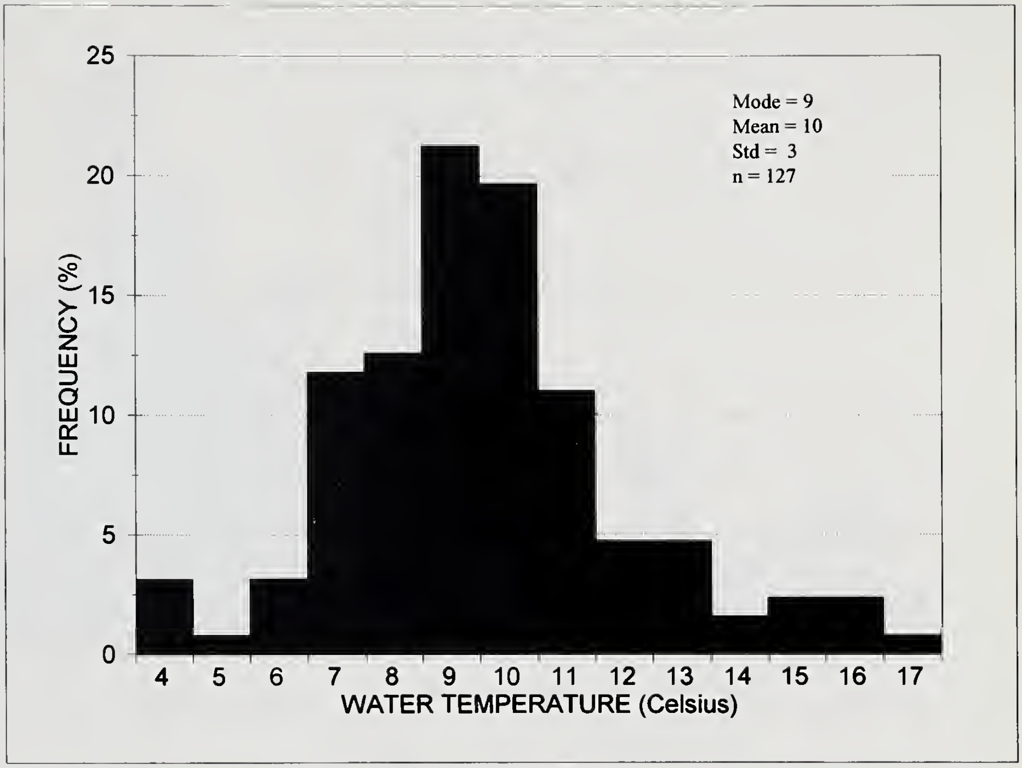

Figure 50—Frequency distribution displaying the range of water temperature for "A" channel reach types.

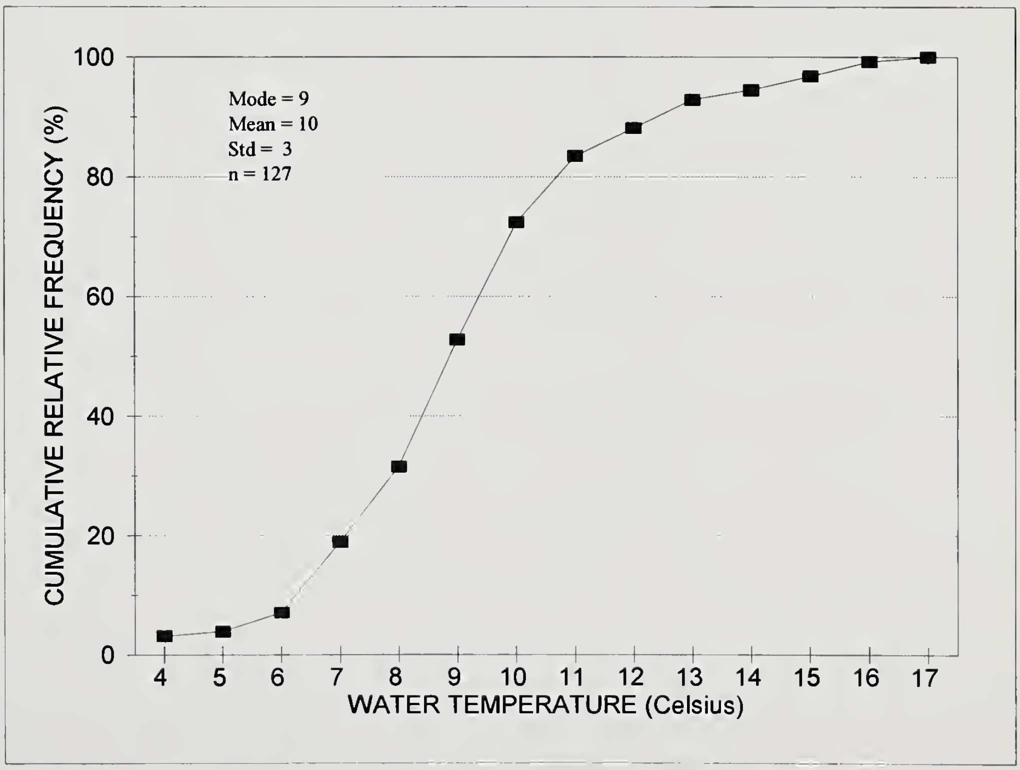

Figure 51—Cumulative relative frequency distribution displaying the range of water temperature for "A" channel reach types.

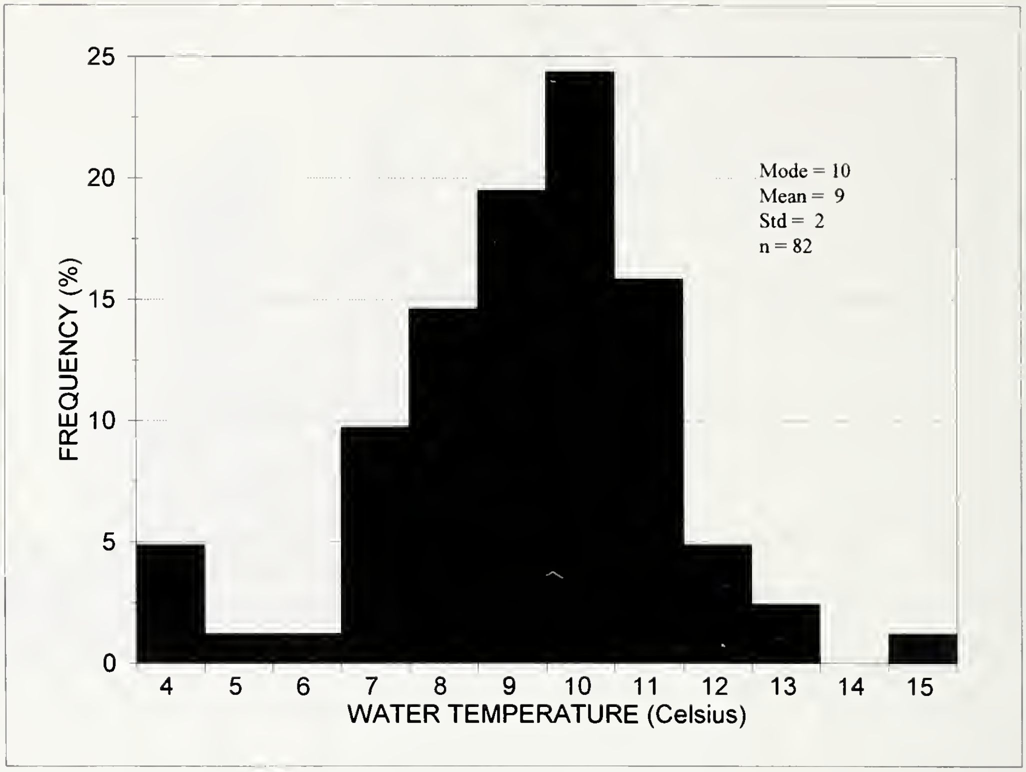

Figure 52—Frequency distribution displaying the range of water temperature for "A" channel plutonic stream reaches.

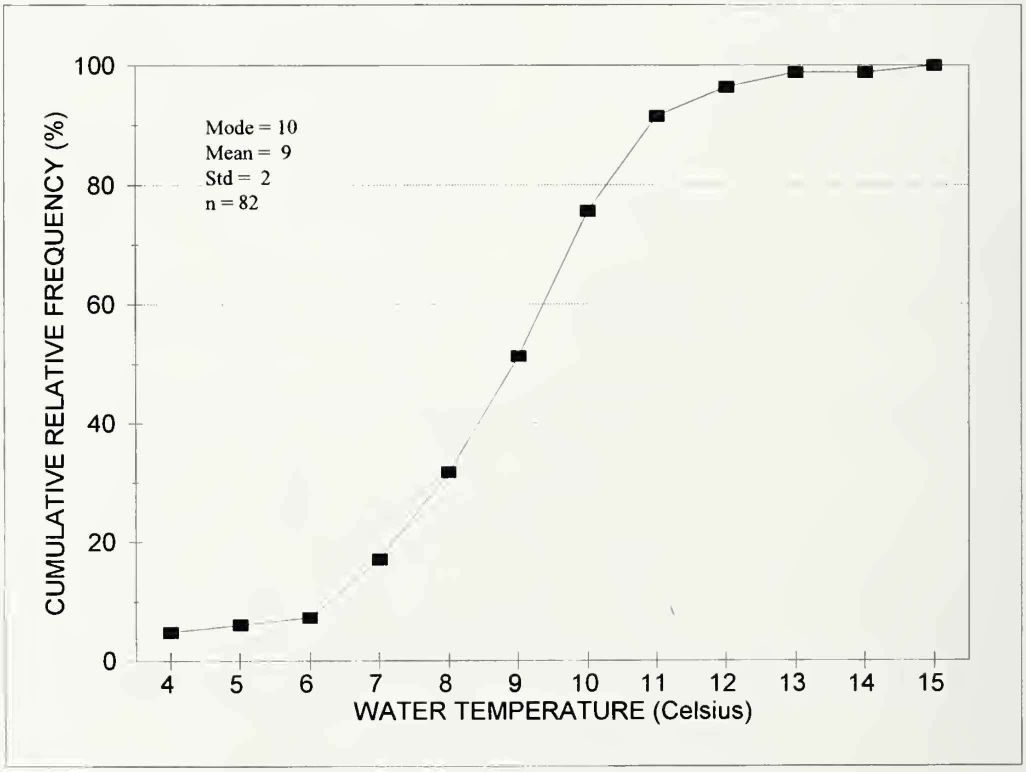

Figure 53—Cumulative relative frequency distribution displaying the range of percent bank stability for "A" channel plutonic stream reaches.

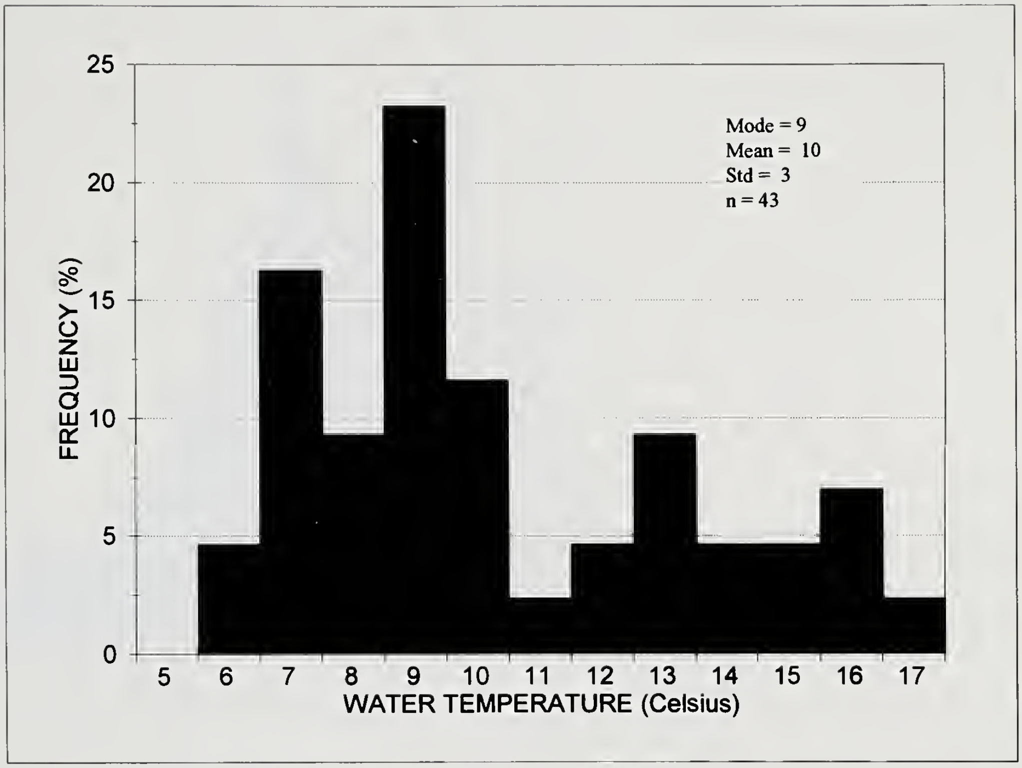

Figure 54—Frequency distribution displaying the range of water temperature for "A" channel metamorphic stream reaches.

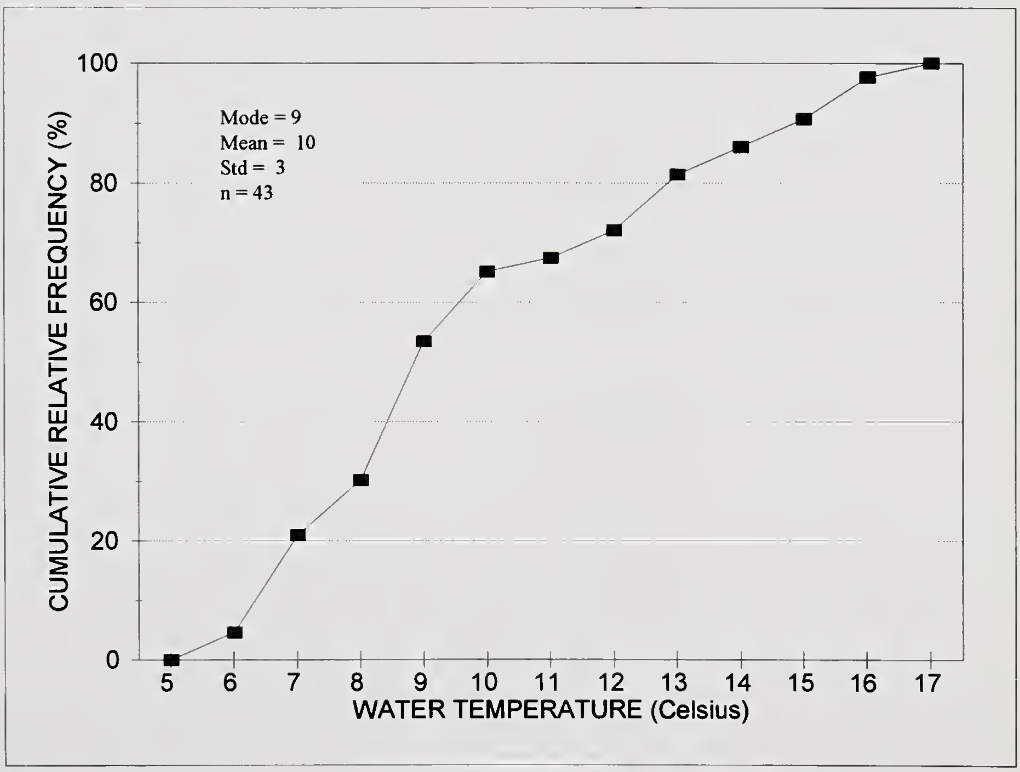

Figure 55—Cumulative relative frequency distribution displaying the range of water temperature for "A" channel metamorphic stream reaches.

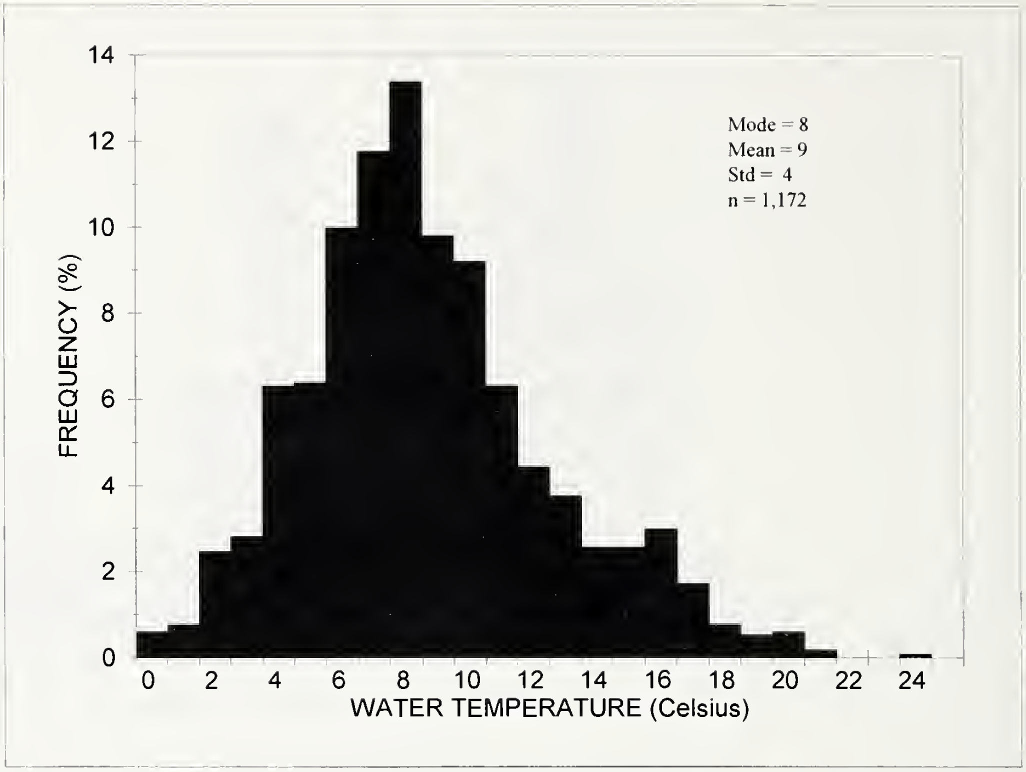

Figure 56—Frequency distribution displaying the range of water temperature for "B" channel reach types.

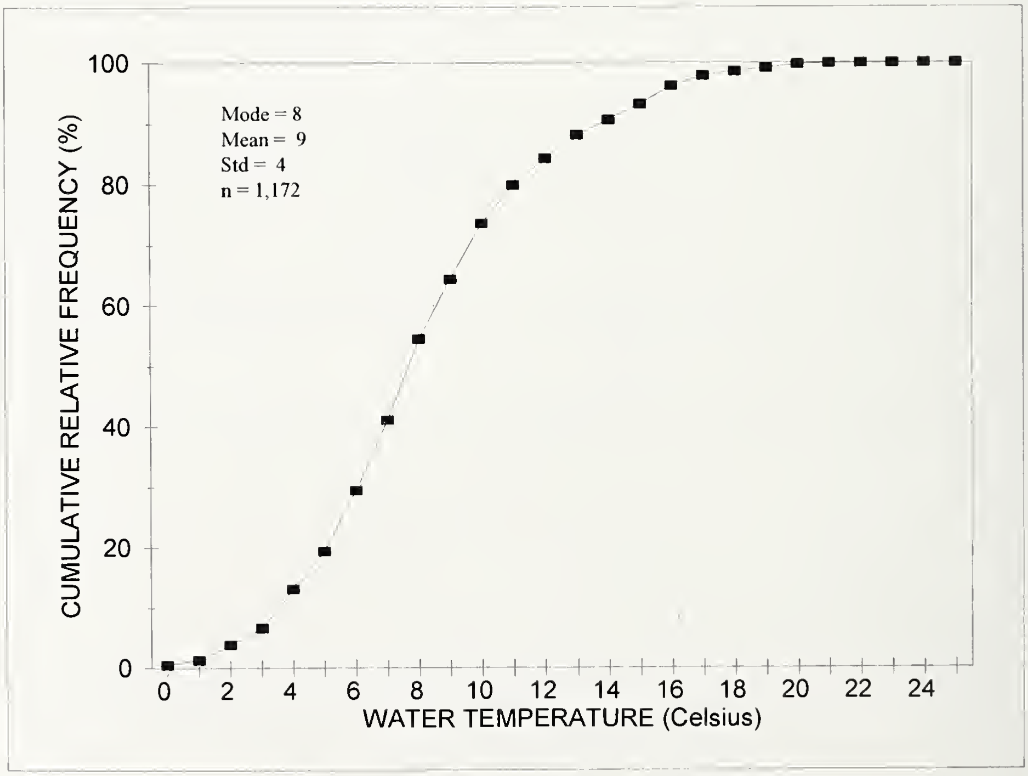

Figure 57—Cumulative relative frequency distribution displaying the range of water temperature for "B" channel reach types.

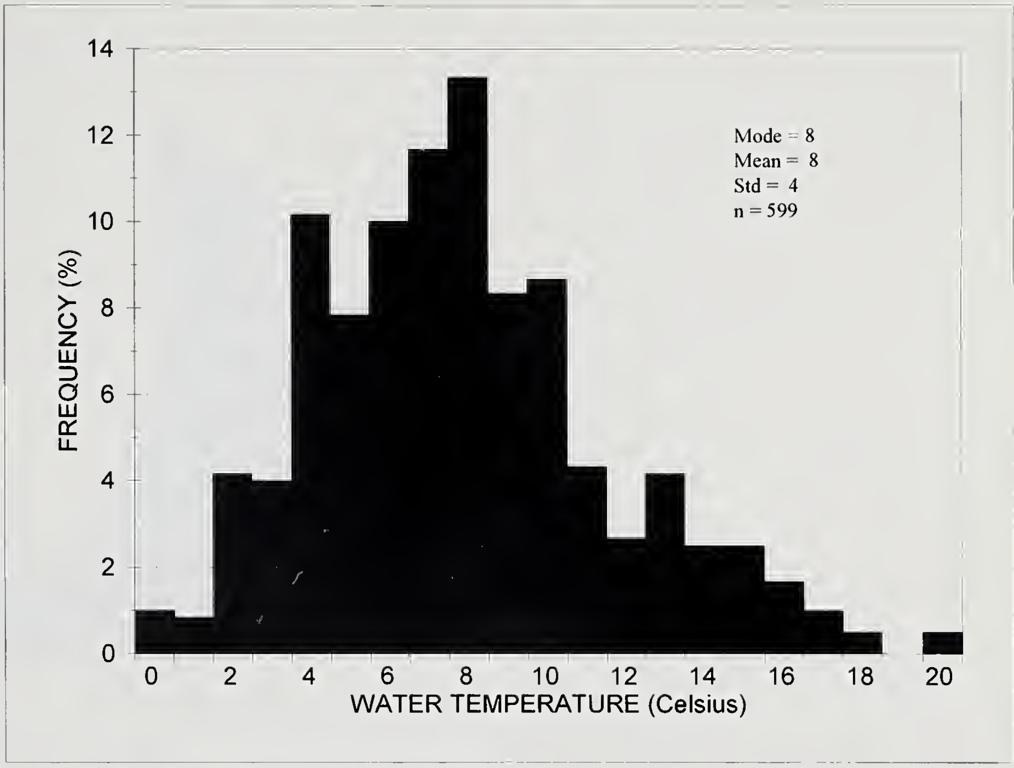

Figure 58—Frequency distribution displaying the range of water temperature for "B" channel plutonic stream reaches.

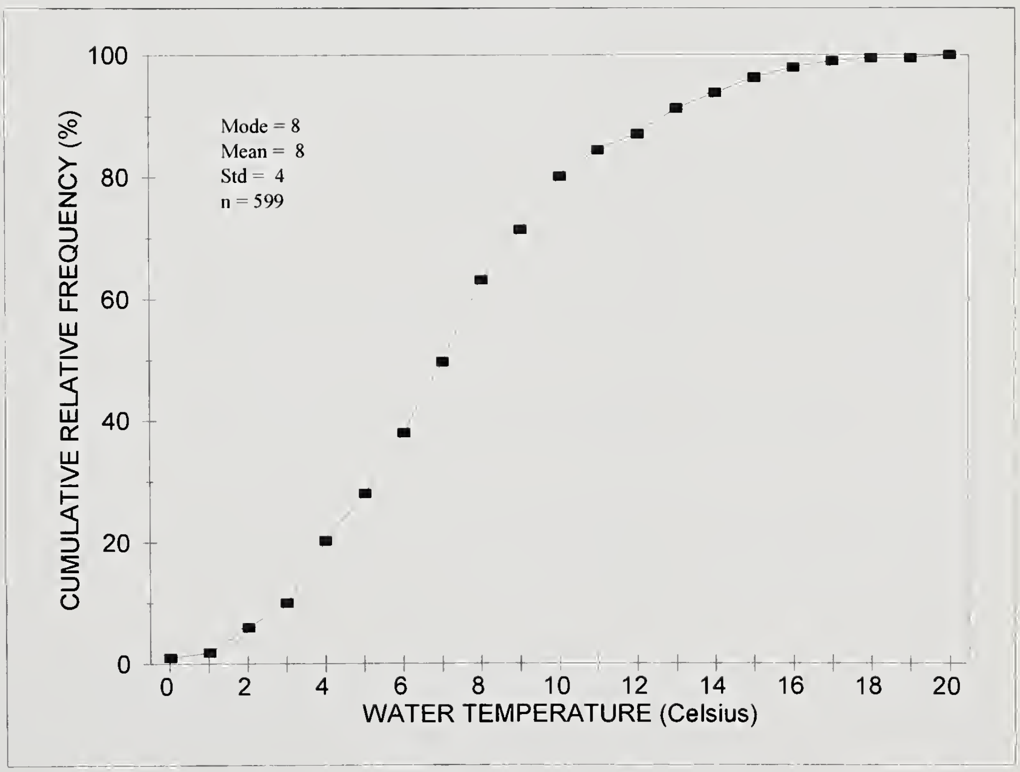

Figure 59—Cumulative relative frequency distribution displaying the range of water temperature for "B" channel plutonic stream reaches.

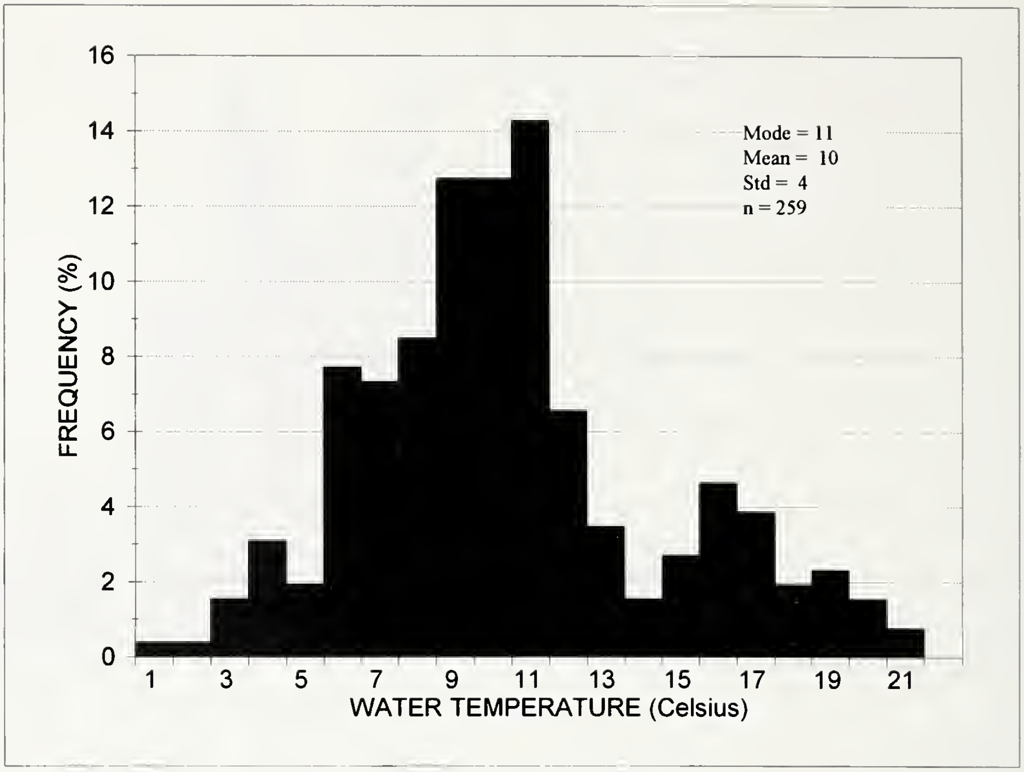

Figure 60—Frequency distribution displaying the range of water temperature for "B" channel volcanic stream reaches.

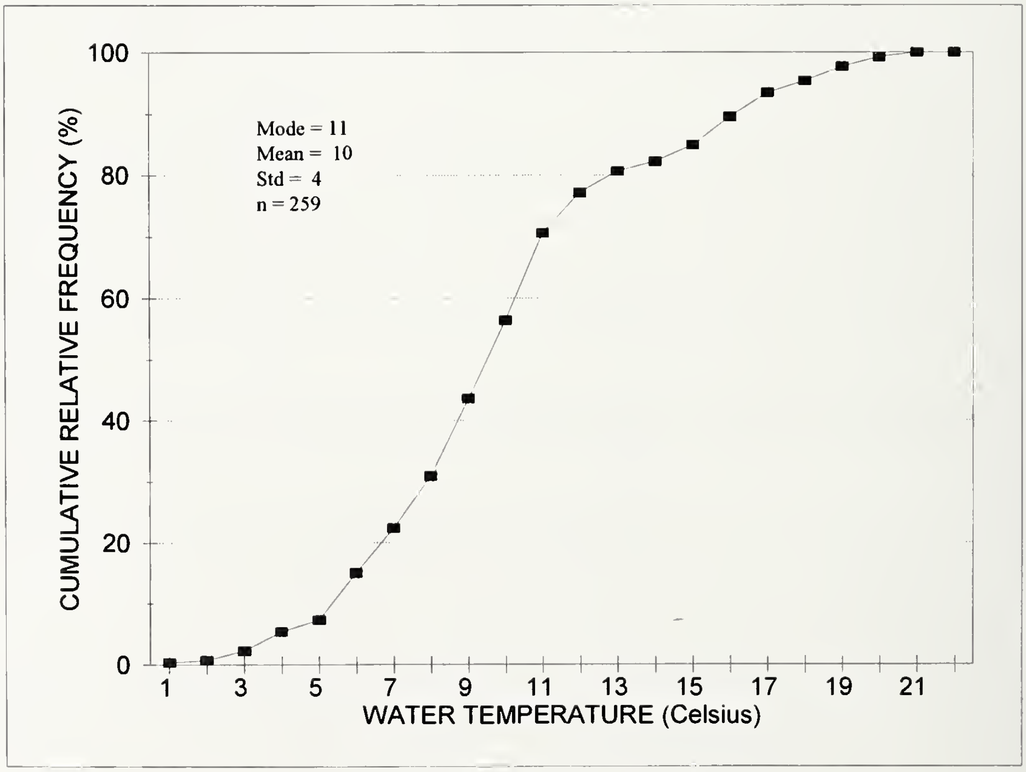

Figure 61—Cumulative relative frequency distribution displaying the range of water temperature for "B" channel volcanic stream reaches.

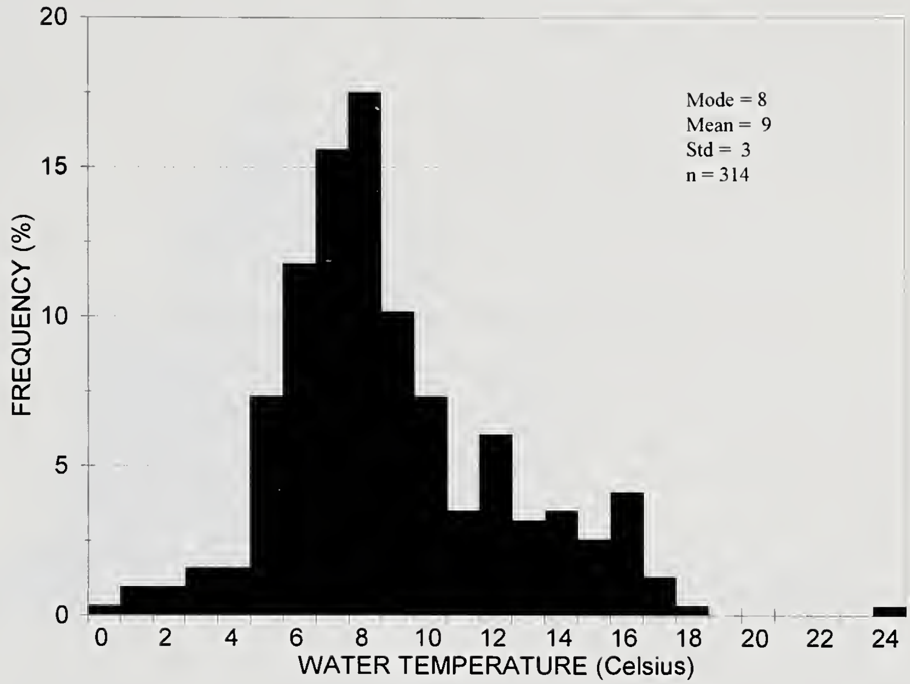

Figure 62—Frequency distribution displaying the range of water temperature for "B" channel metamorphic stream reaches.

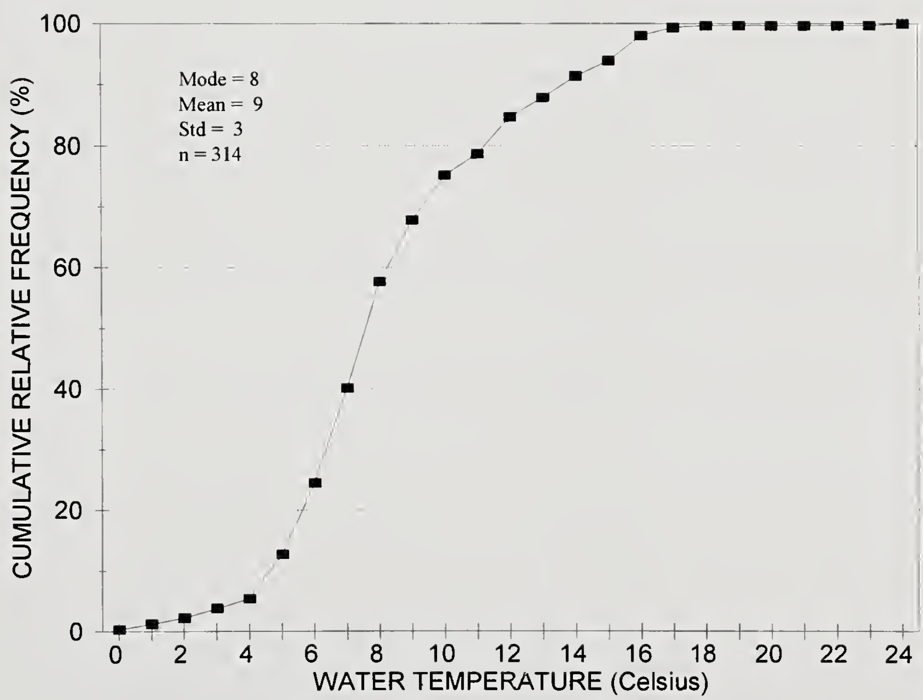

Figure 63—Cumulative relative frequency distribution displaying the range of water temperature for "B" channel metamorphic stream reaches.

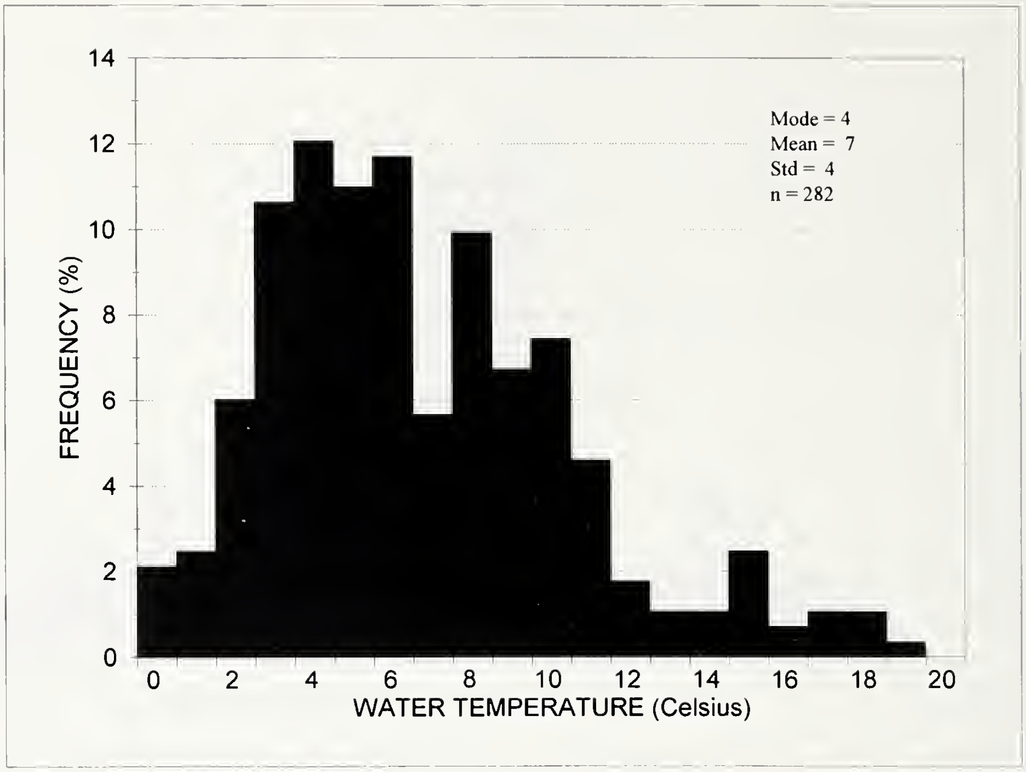

Figure 64—Frequency distribution displaying the range of water temperature for "C" channel reach types.

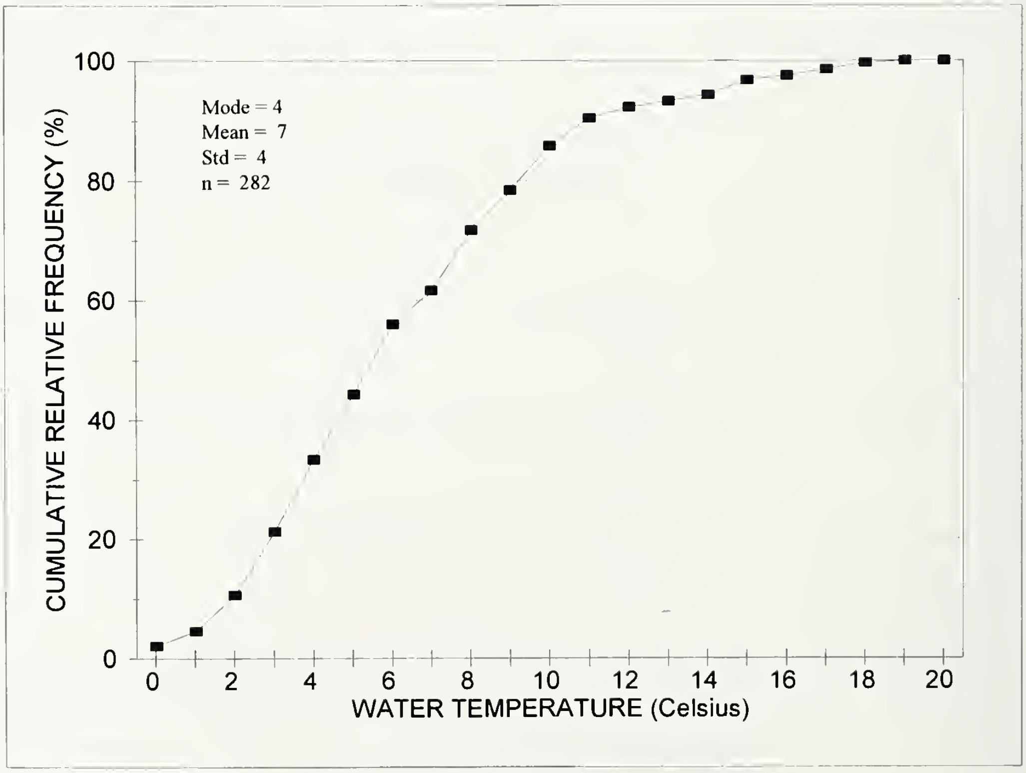

Figure 65—Cumulative relative frequency distribution displaying the range of water temperature for "C" channel reach types.

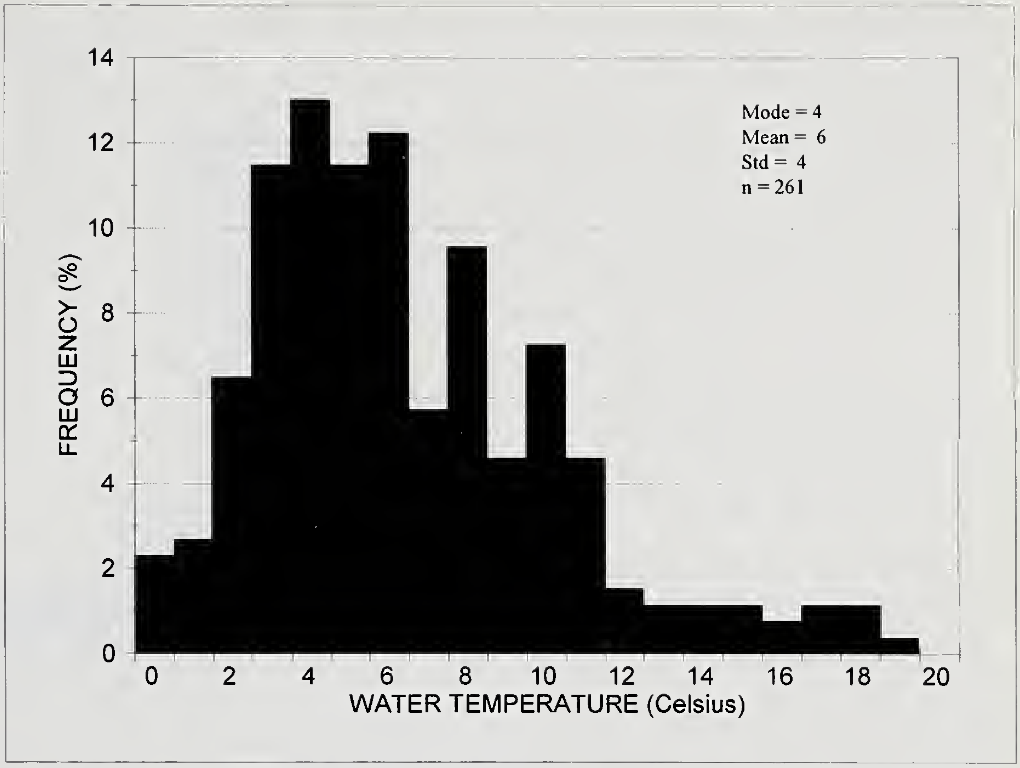

Figure 66—Frequency distribution displaying the range of water temperature for "C" channel plutonic stream reaches.

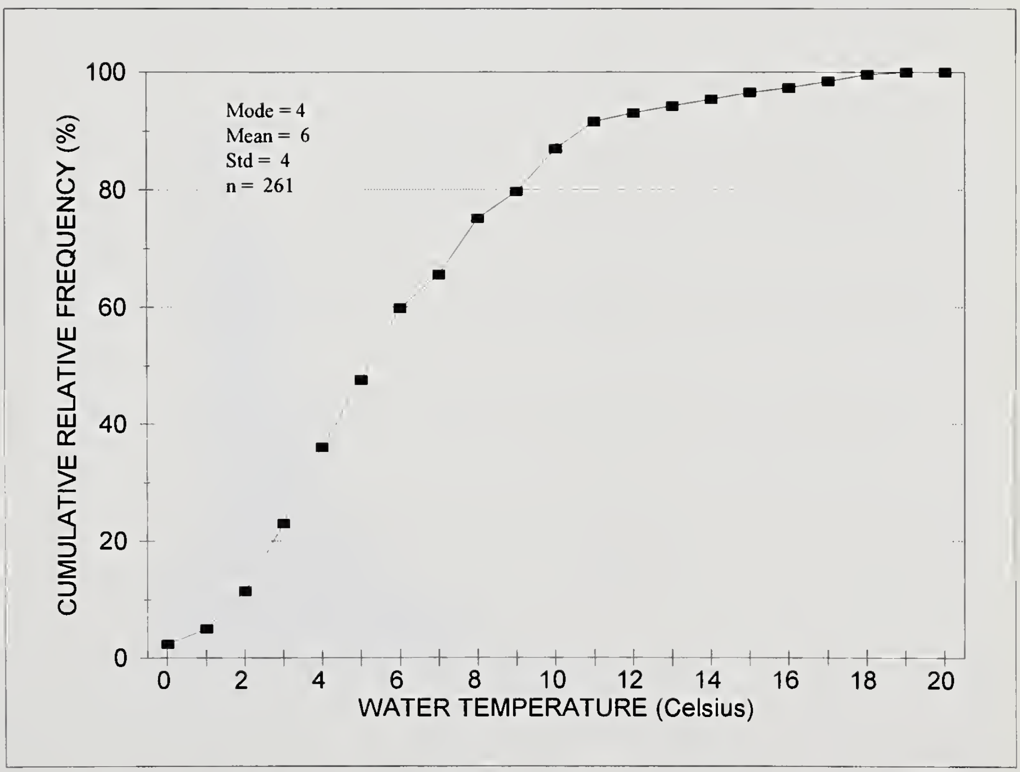

Figure 67—Cumulative relative frequency distribution displaying the range of water temperature for "C" channel plutonic stream reaches.

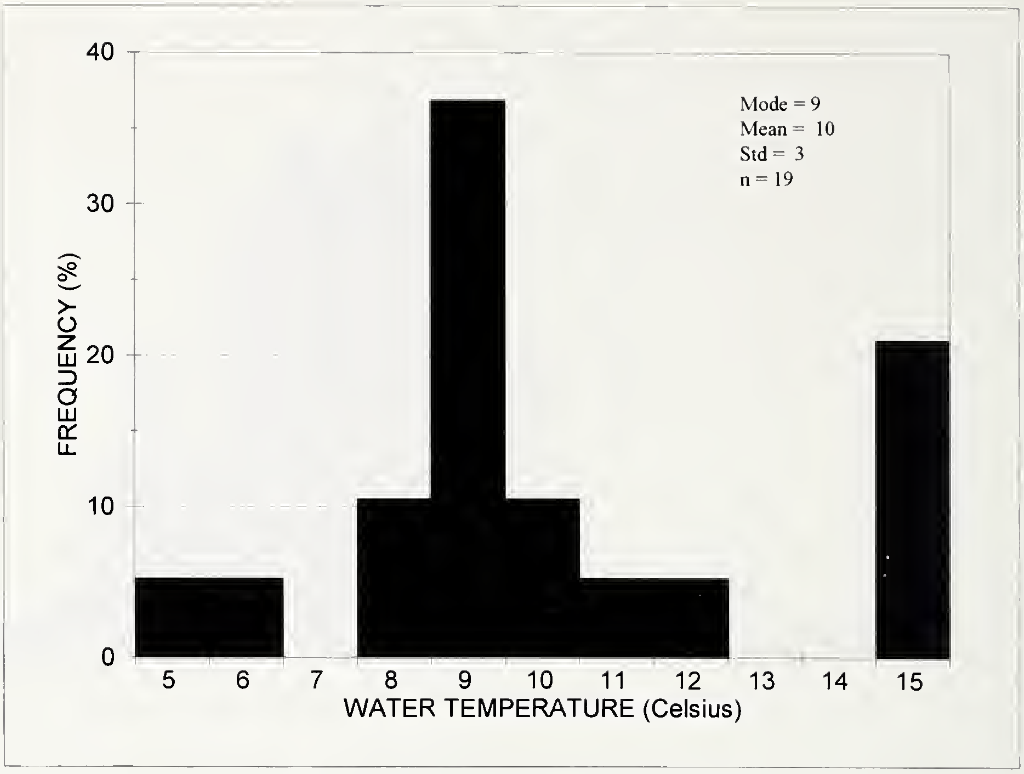

Figure 68—Frequency distribution displaying the range of water temperature for "C" channel volcanic stream reaches.

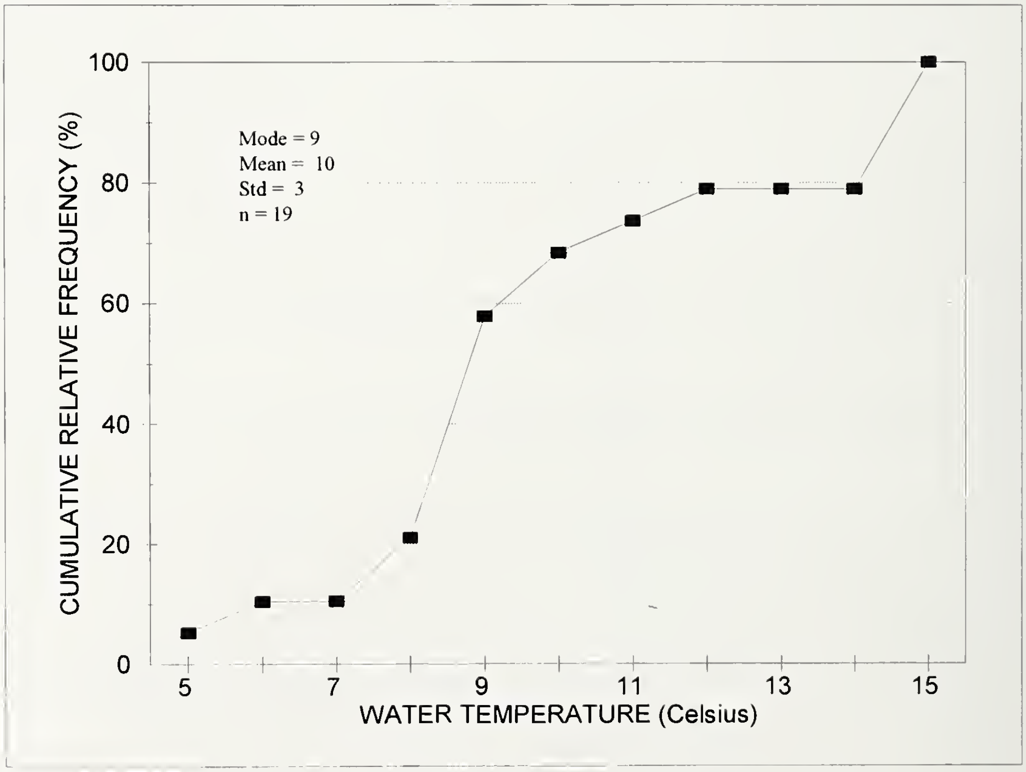

Figure 69—Cumulative relative frequency distribution displaying the range of water temperature for "C" channel volcanic stream reaches.

Width-To-Depth and Width-To-Maximum-Depth Ratios

Channel morphology is largely a result of the interactions of sediment and water during peak flow periods forming pools and riffles as sediment is scoured or deposited. Flow obstructions—large woody debris, boulders, bedrock, and bank vegetation—create local hydraulic conditions resulting in a variety of widths, depths, and velocities. The width-to-depth ratio provides a dimensionless index of channel morphology and can be an indicator of change in the relative balance between sediment load and sediment transport capacity (Clifton 1989; MacDonald and others 1991). Large width-to-depth ratios are often a result of lateral bank excursion due to increased peak flows, sedimentation, and eroding banks.

A width-to-depth ratio is calculated for each habitat type based on wetted mean width and mean depth. A width-to-maximum-depth ratio is calculated for scour pools based on mean scour pool width and maximum depth. Pool maximum depth appears to be a more repeatable measurement than mean depth. When comparing width-to-depth ratios, drainage areas should be similar.

Some habitat types may skew the width-to-depth ratios. For example, dammed pools may flood several times the mean channel width. If these habitat types exist, they should be eliminated from site-specific analysis. Figures 70 through 95 are the statistical summaries for width-to-depth ratios grouped by all surveyed stream reaches, by channel reach types, and by channel reach types and geology. Figures 96 through 121 are the statistical summaries for width-to-maximum-depth for scour pools grouped by all surveyed stream reaches, by channel reach types, and by channel reach types and geology.

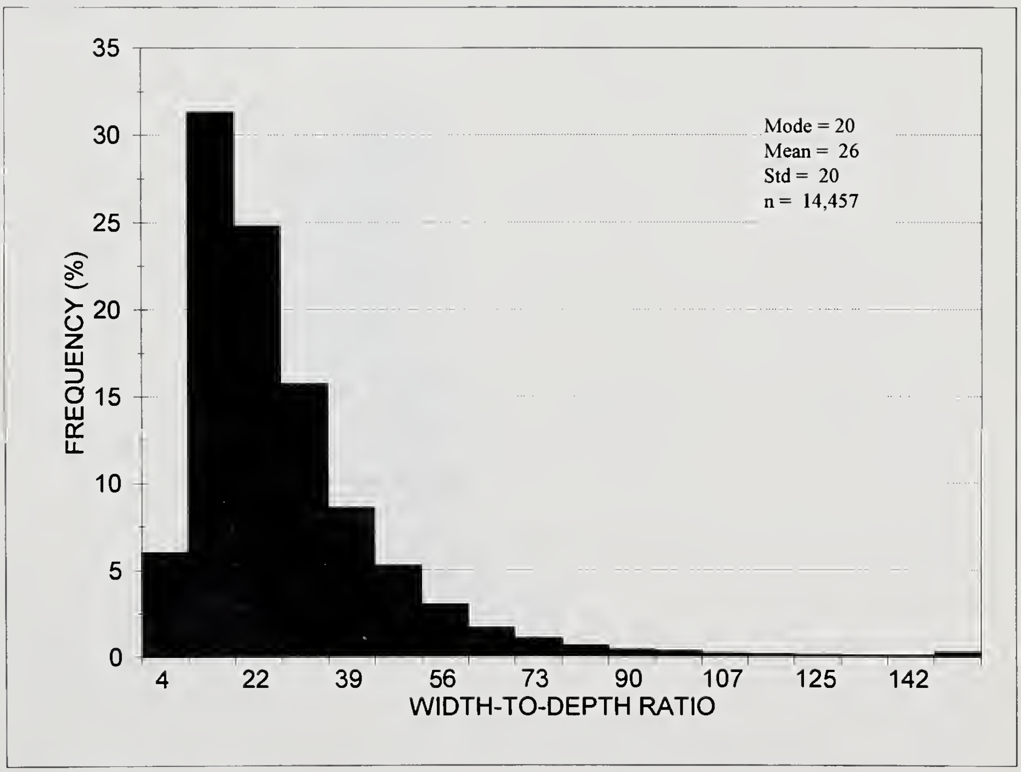

Figure 70—Frequency distribution displaying the range of width-to-depth ratios for all channel reach types.

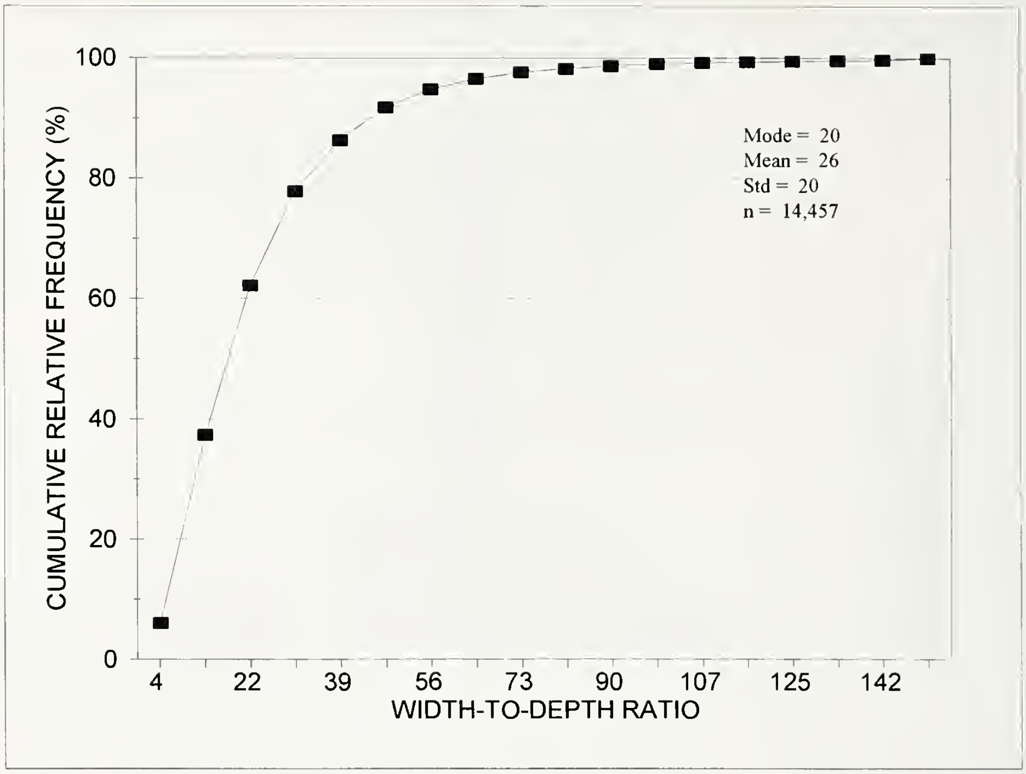

Figure 71—Cumulative relative frequency distribution displaying the range of width-to-depth ratios for all channel reach types.

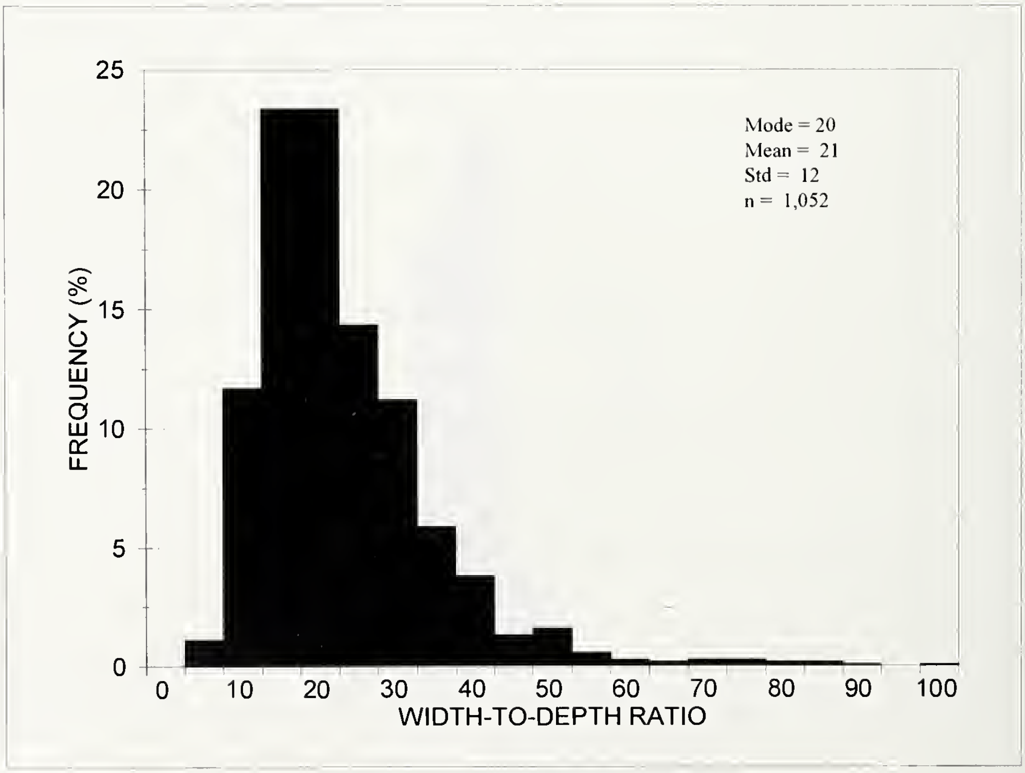

Figure 72—Frequency distribution displaying the range of width-to-depth ratios for "A" channel reach types.

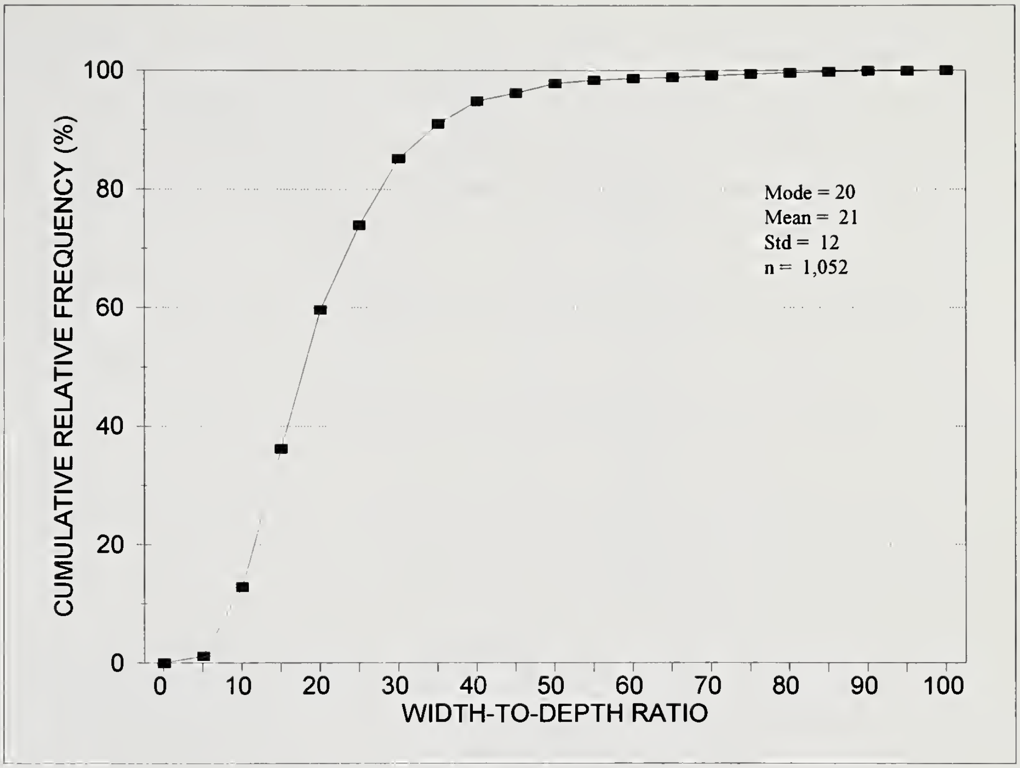

Figure 73—Cumulative relative frequency distribution displaying the range of width-to-depth ratios for "A" channel reach types.

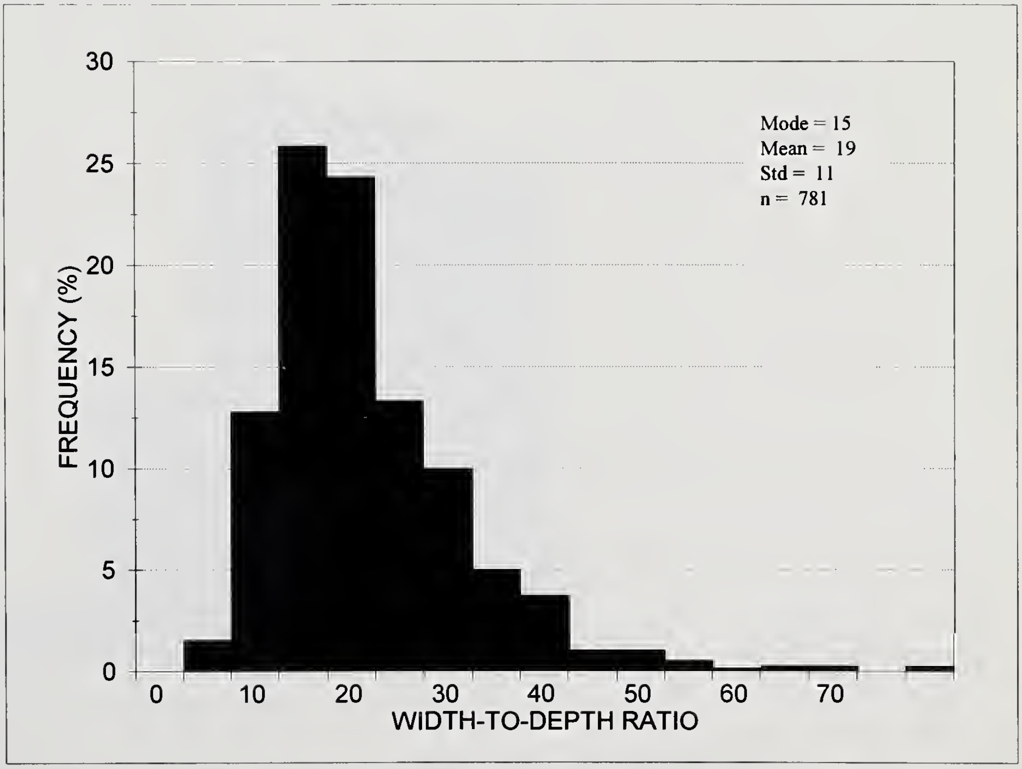

Figure 74—Frequency distribution displaying the range of width-to-depth ratios for "A" channel plutonic stream reaches.

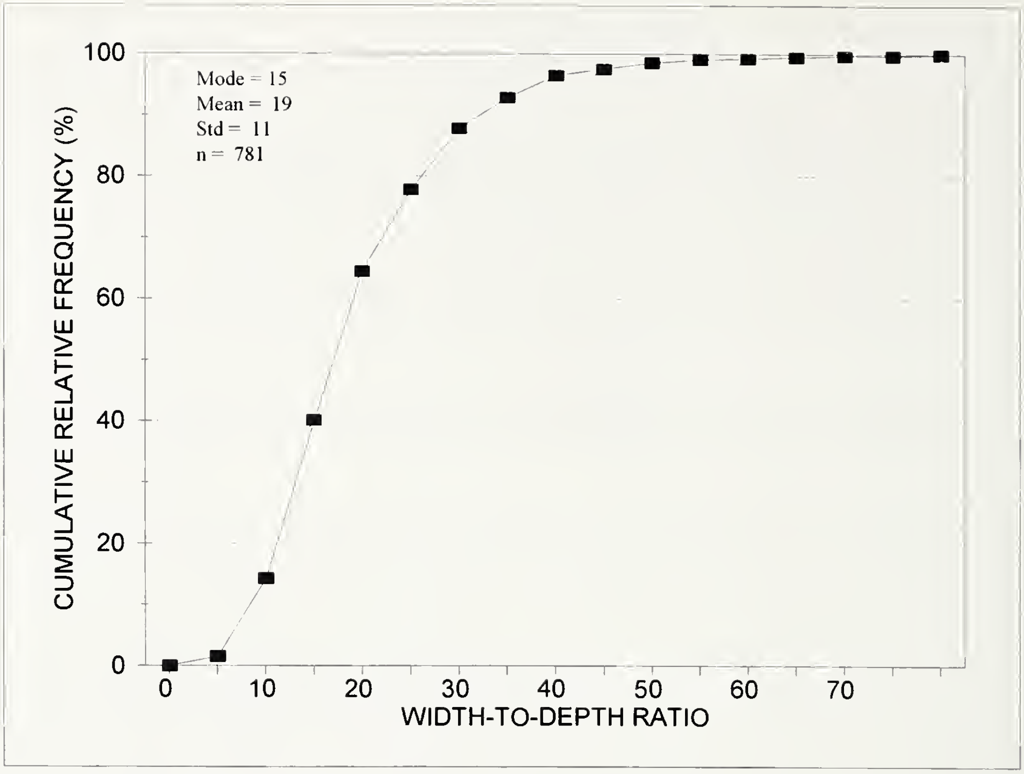

Figure 75—Cumulative relative frequency distribution displaying the range of width-to-depth ratios for "A" channel plutonic stream reaches.

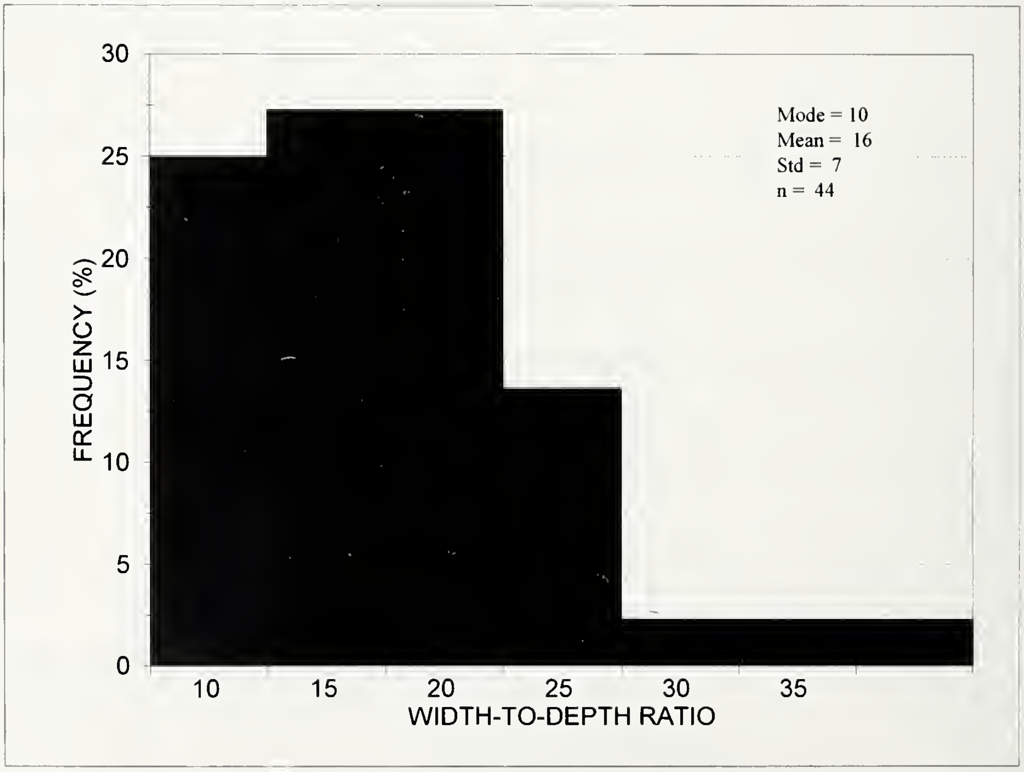

Figure 76—Frequency distribution displaying the range of width-to-depth ratios for "A" channel volcanic stream reaches.

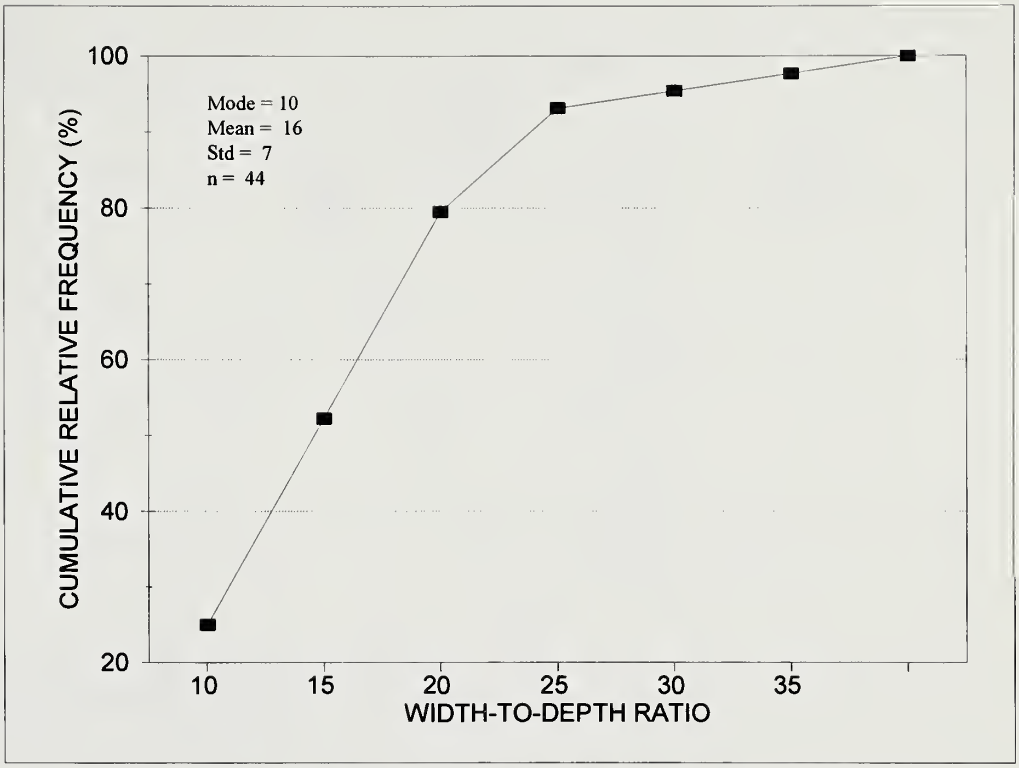

Figure 77—Cumulative relative frequency distribution displaying the range of width-to-depth ratios for "A" channel volcanic stream reaches.

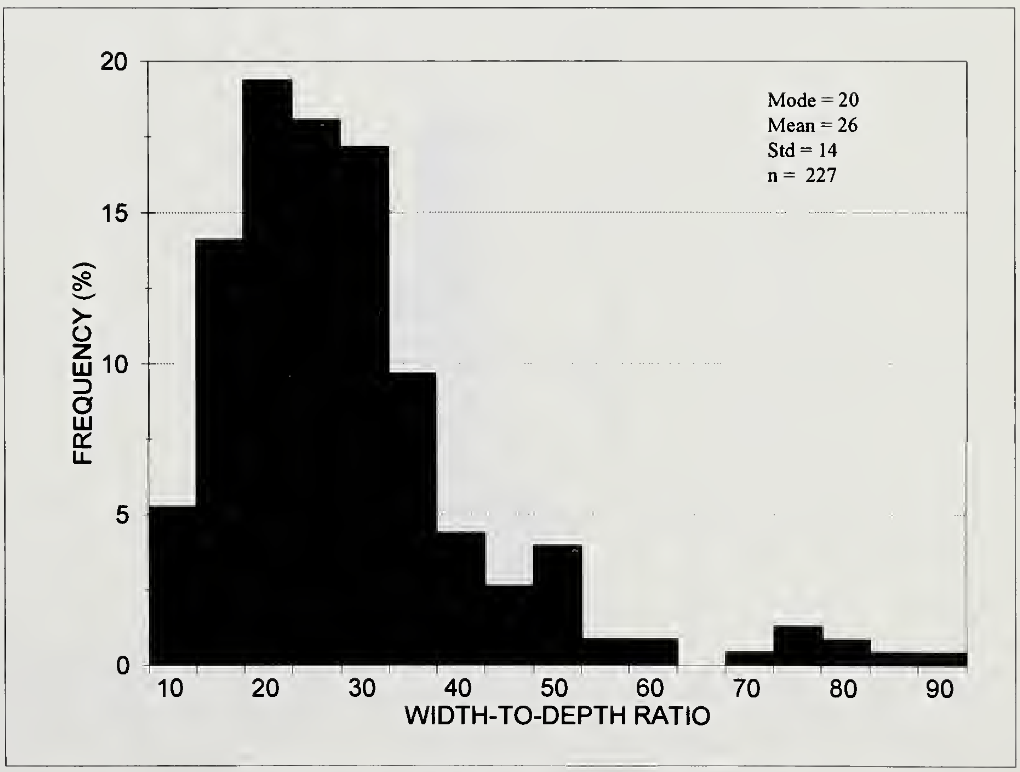

Figure 78—Frequency distribution displaying the range of width-to-depth ratios for "A" channel metamorphic stream reaches.

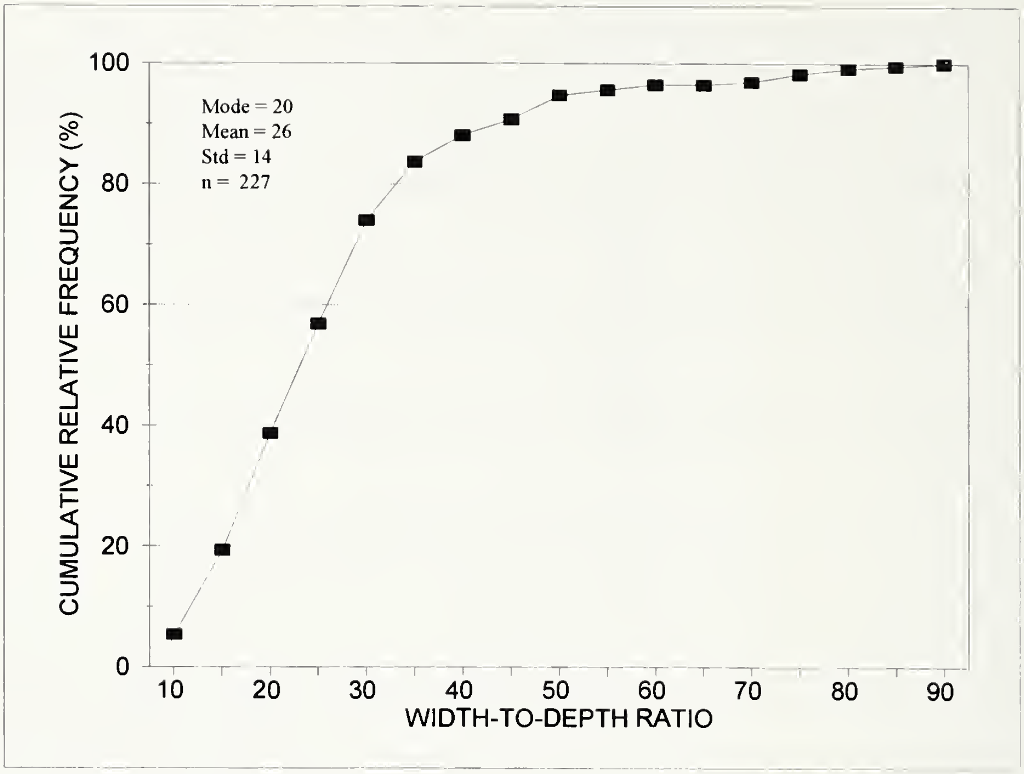

Figure 79—Cumulative relative frequency distribution displaying the range of width-to-depth ratios for "A" channel metamorphic stream reaches

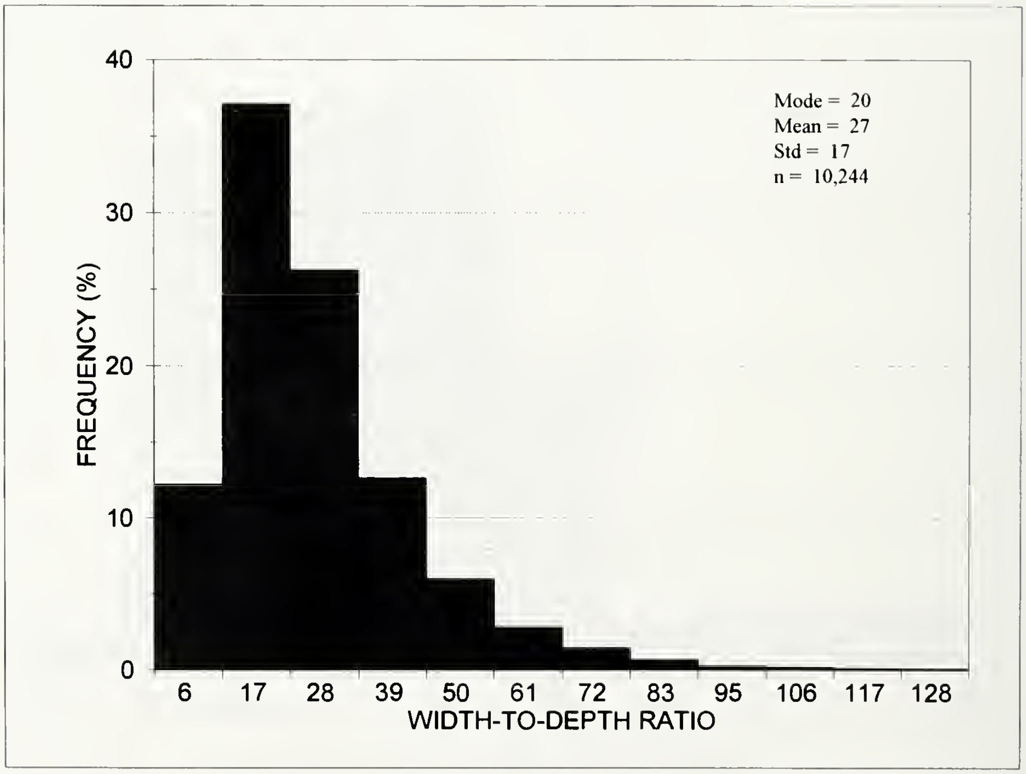

Figure 80—Frequency distribution displaying the range of width-to-depth ratios for "B" channel reach types.

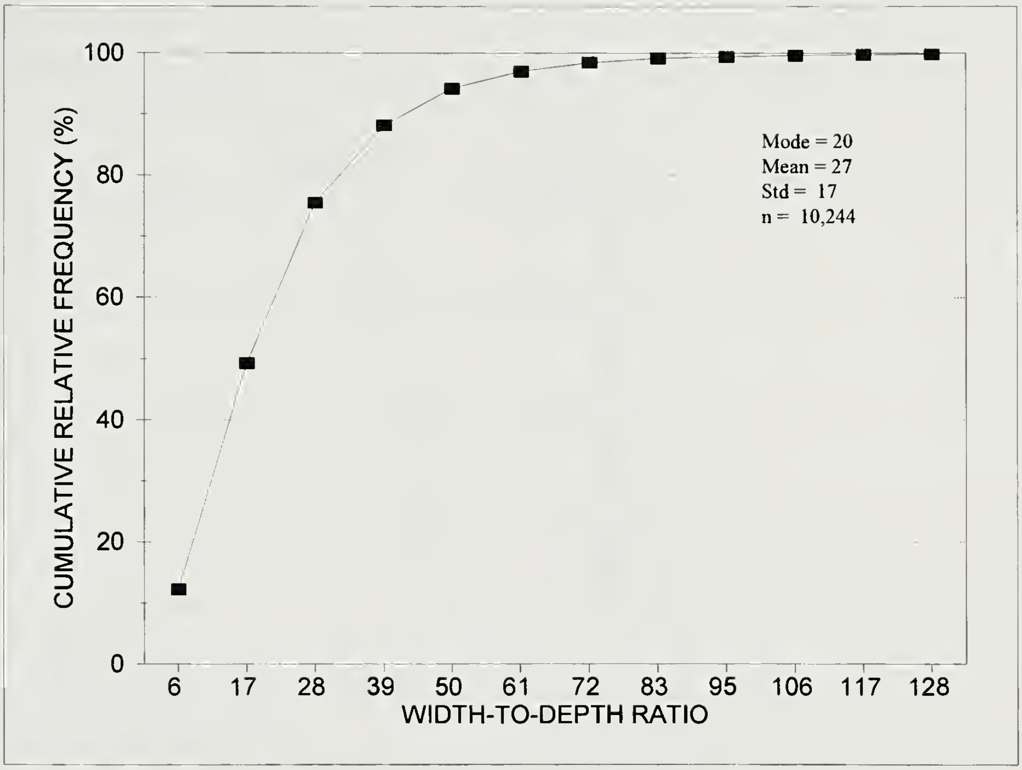

Figure 81—Cumulative relative frequency distribution displaying the range of width-to-depth ratios for "B" channel reach types.

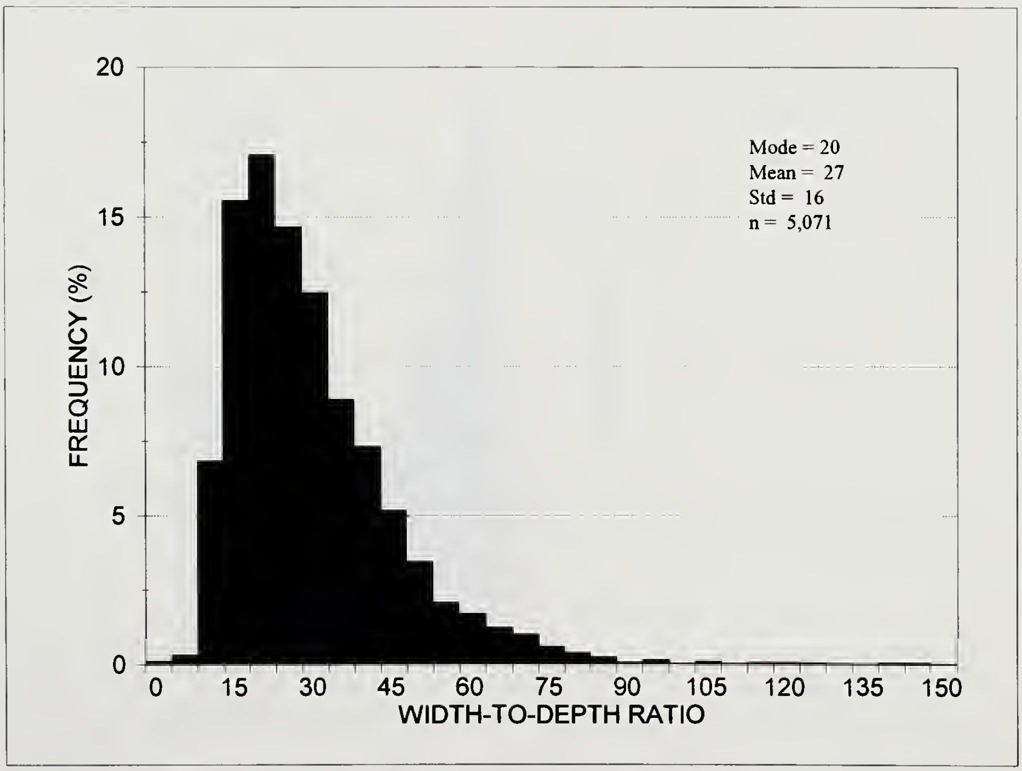

Figure 82—Frequency distribution displaying the range of width-to-depth ratios for "B" channel plutonic stream reaches.

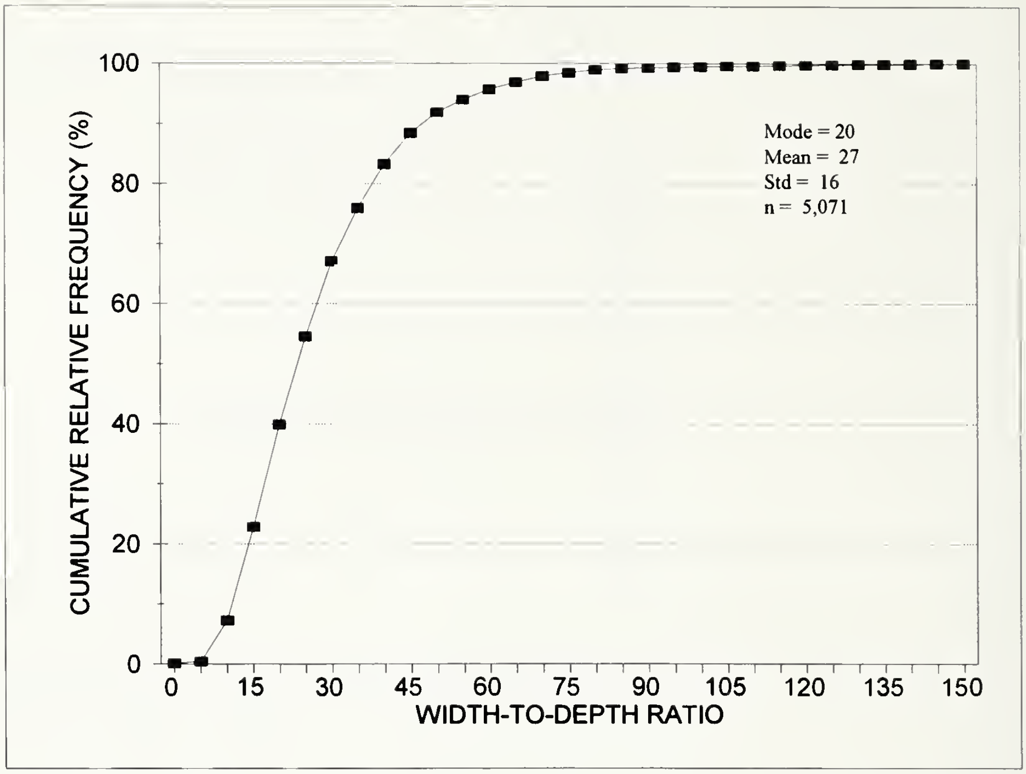

Figure 83—Cumulative relative frequency distribution displaying the range of width-to-depth ratios for "B" channel plutonic stream reaches.

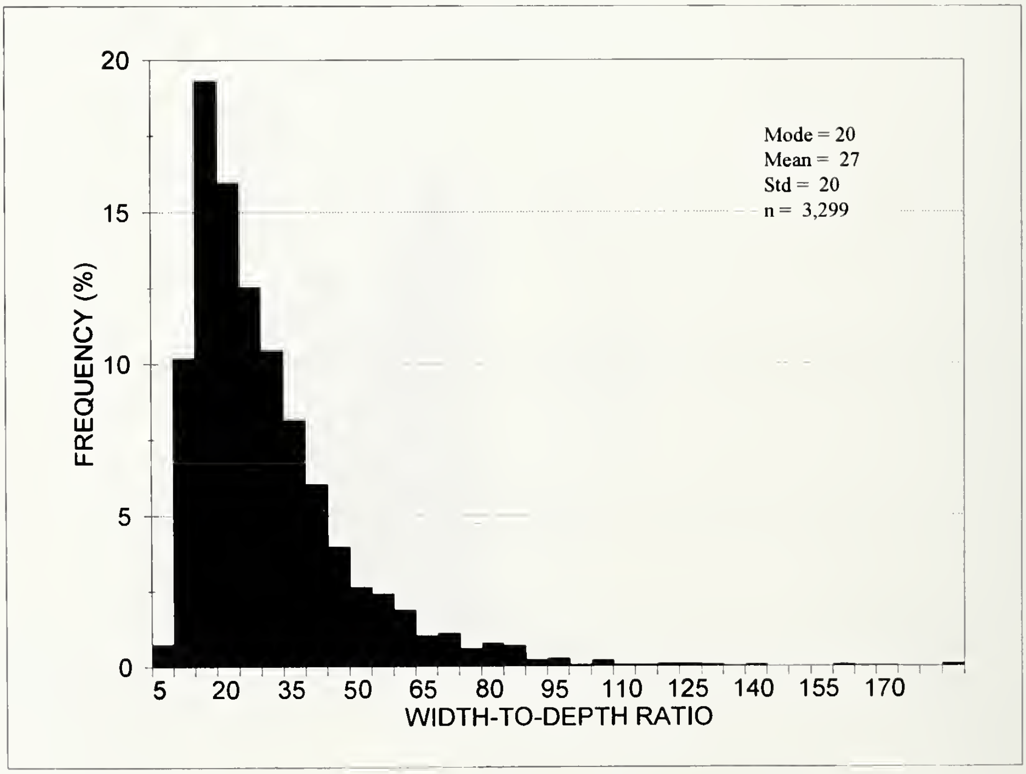

Figure 84—Frequency distribution displaying the range of width-to-depth ratios for "B" channel volcanic stream reaches.

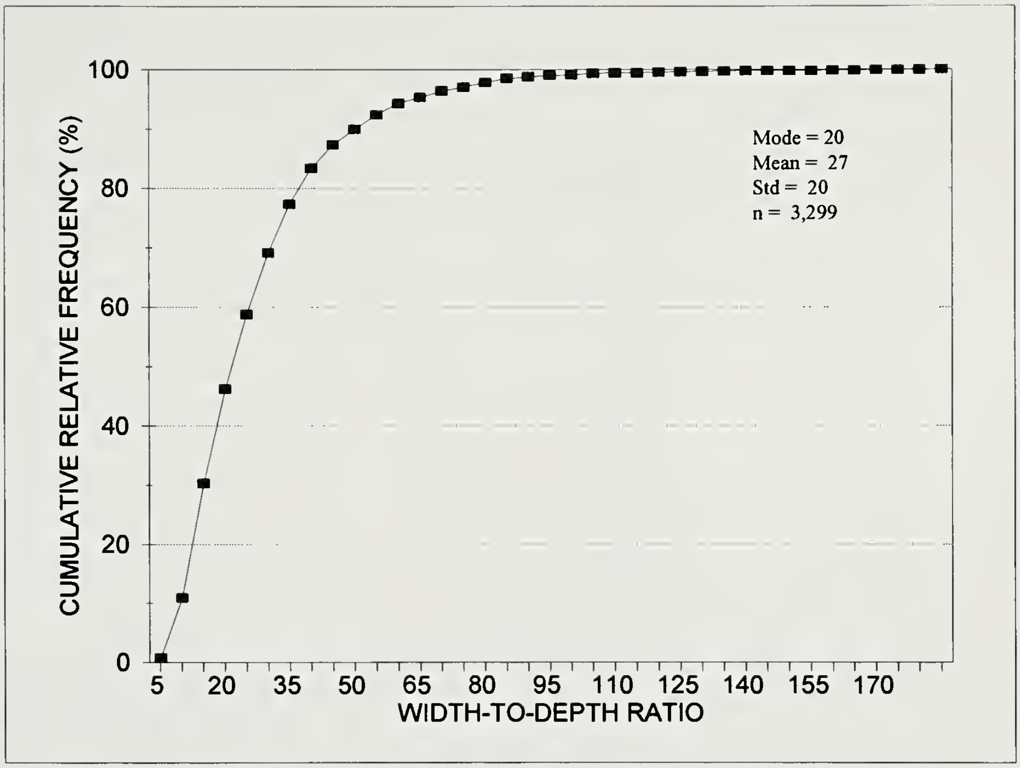

Figure 85—Cumulative relative frequency distribution displaying the range of width-to-depth ratios for "B" channel volcanic stream reaches.

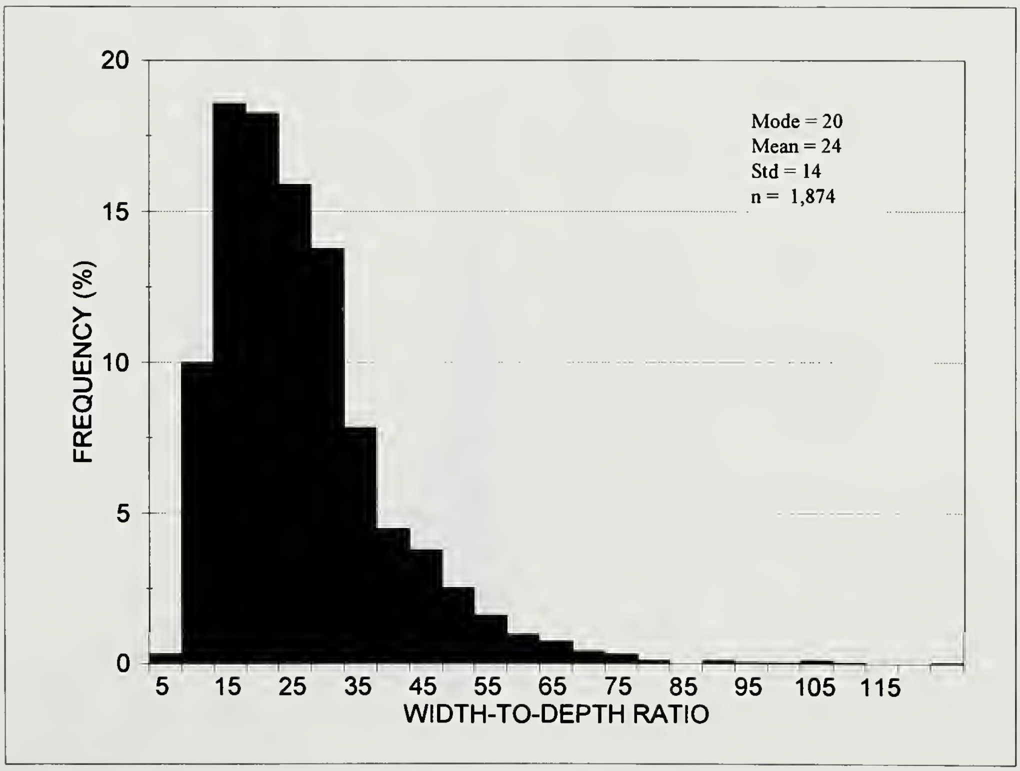

Figure 86—Frequency distribution displaying the range of width-to-depth ratios for "B" channel metamorphic stream reaches.

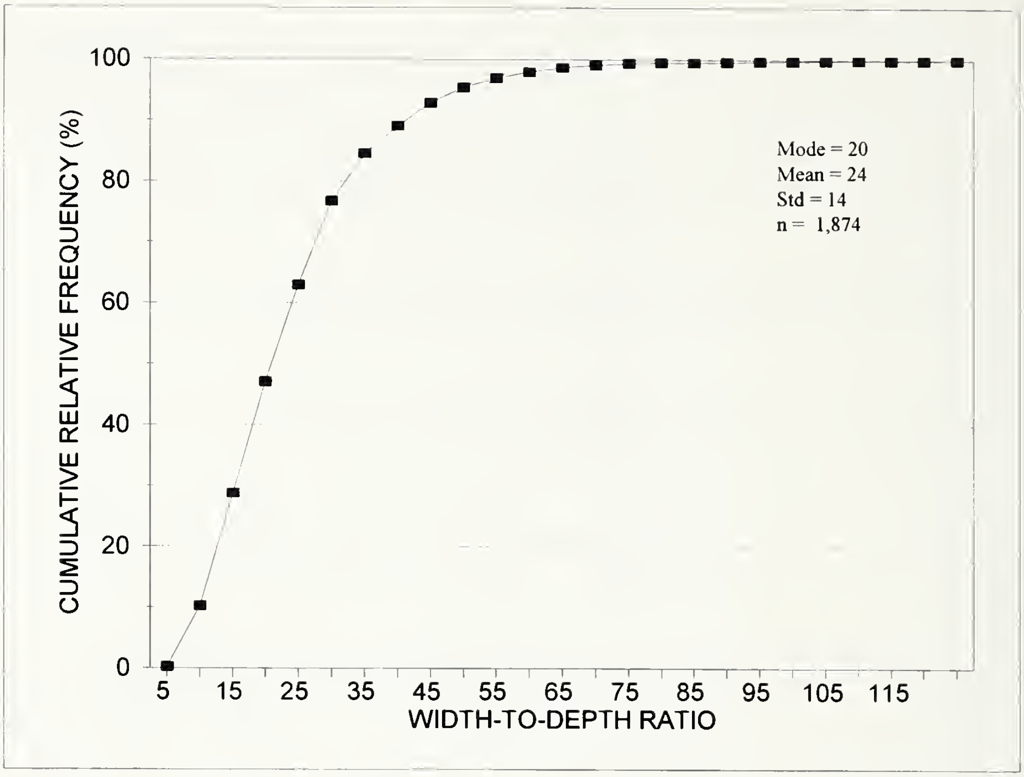

Figure 87—Cumulative relative frequency distribution displaying the range of width-to-depth ratios for "B" channel metamorphic stream reaches.

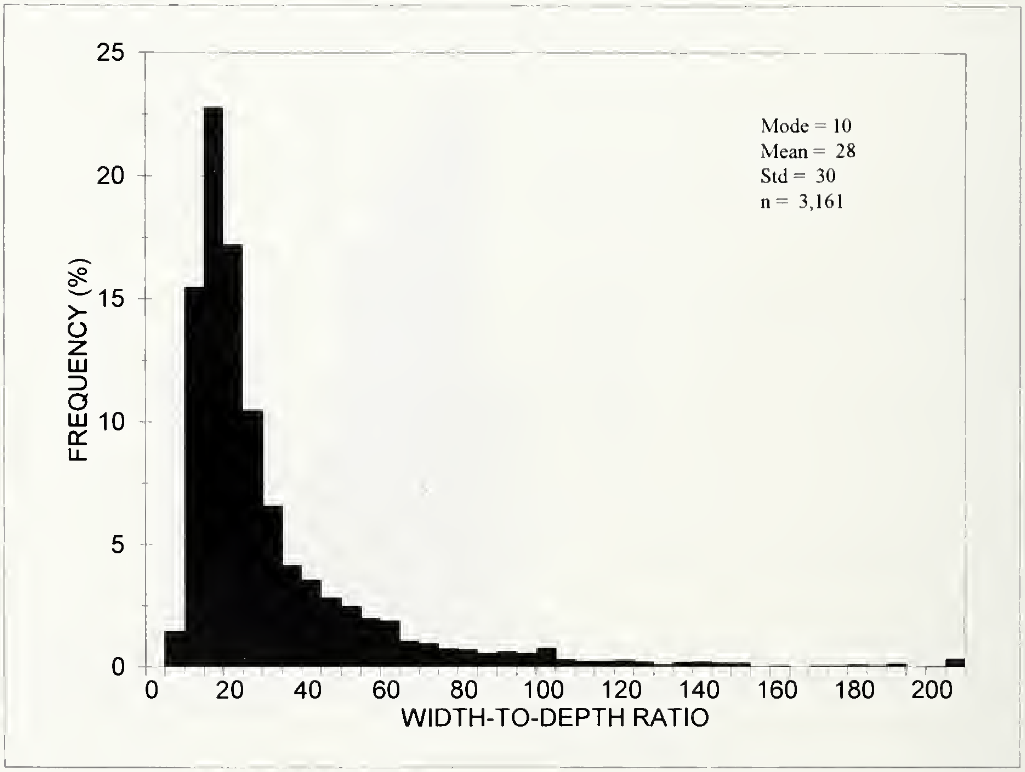

Figure 88—Frequency distribution displaying the range of width-to-depth ratios for "C" channel reach types.

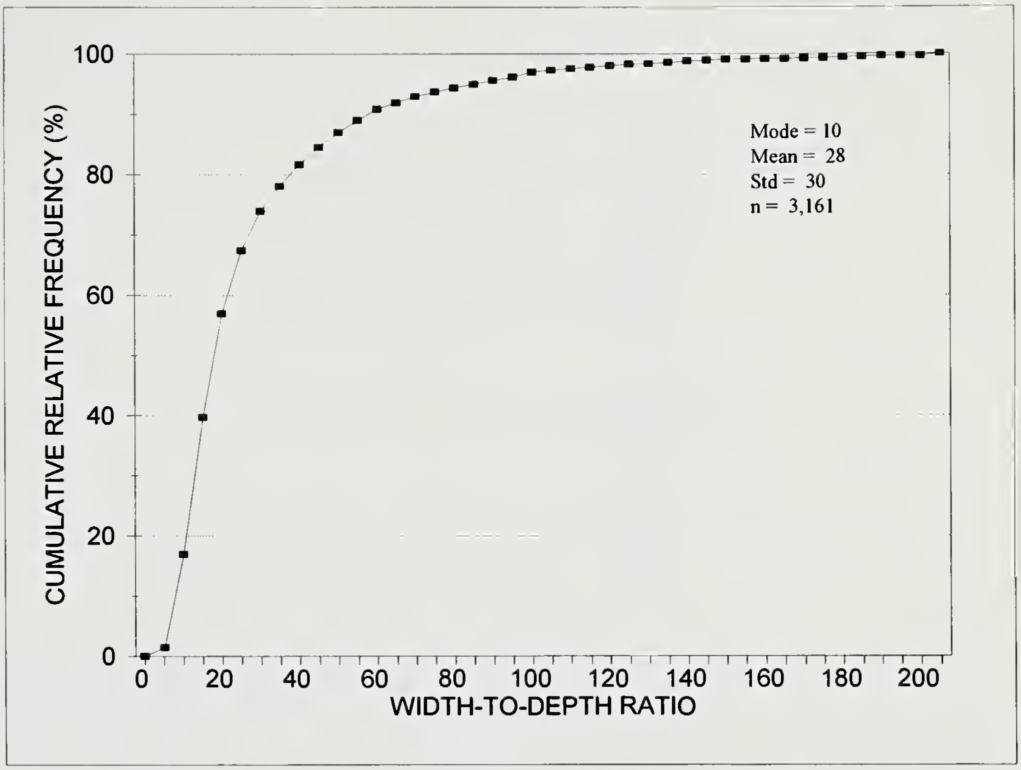

Figure 89—Cumulative relative frequency distribution displaying the range of width-to-depth ratios for "C" channel reach types.

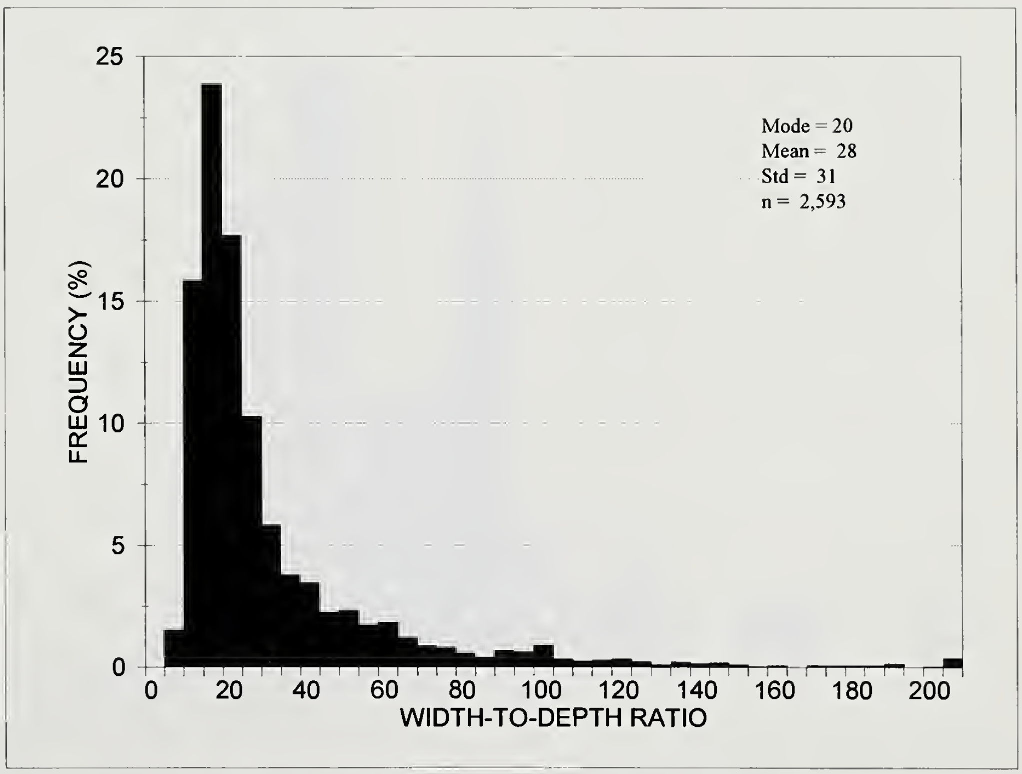

Figure 90—Frequency distribution displaying the range of width-to-depth ratios for "C" channel plutonic stream reaches.

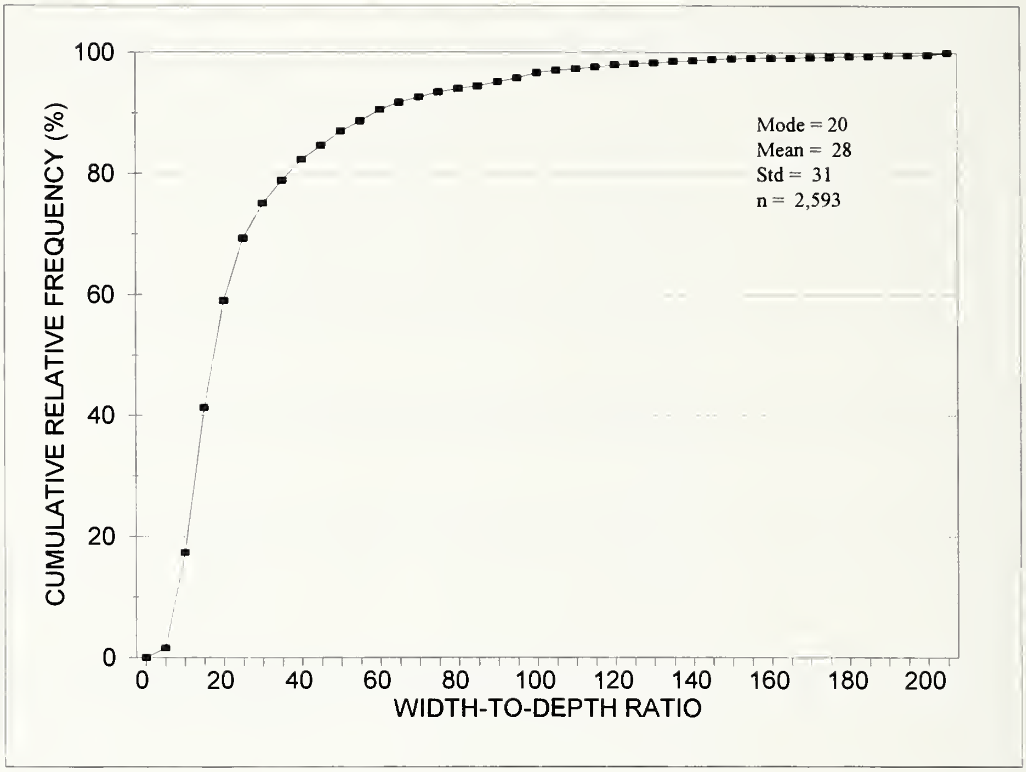

Figure 91—Cumulative relative frequency distribution displaying the range of width-to-depth ratios for "C" channel plutonic stream reaches.

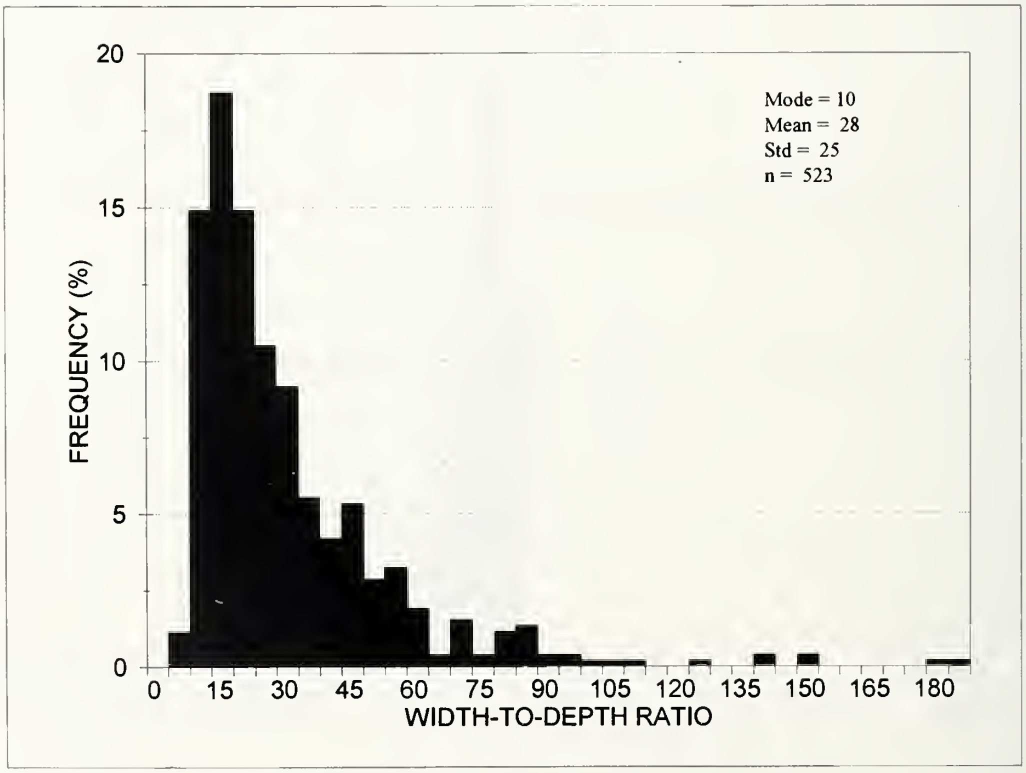

Figure 92—Frequency distribution displaying the range of width-to-depth ratios for "C" channel volcanic stream reaches.

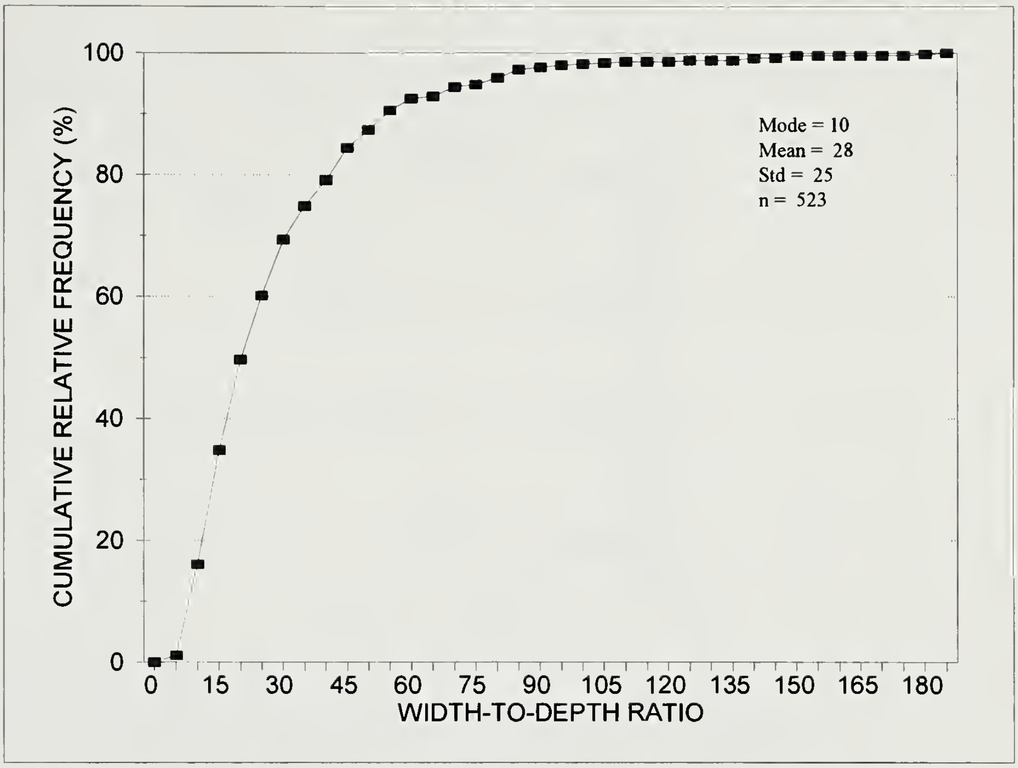

Figure 93—Cumulative relative frequency distribution displaying the range of width-to-depth ratios for "C" channel volcanic stream reaches.

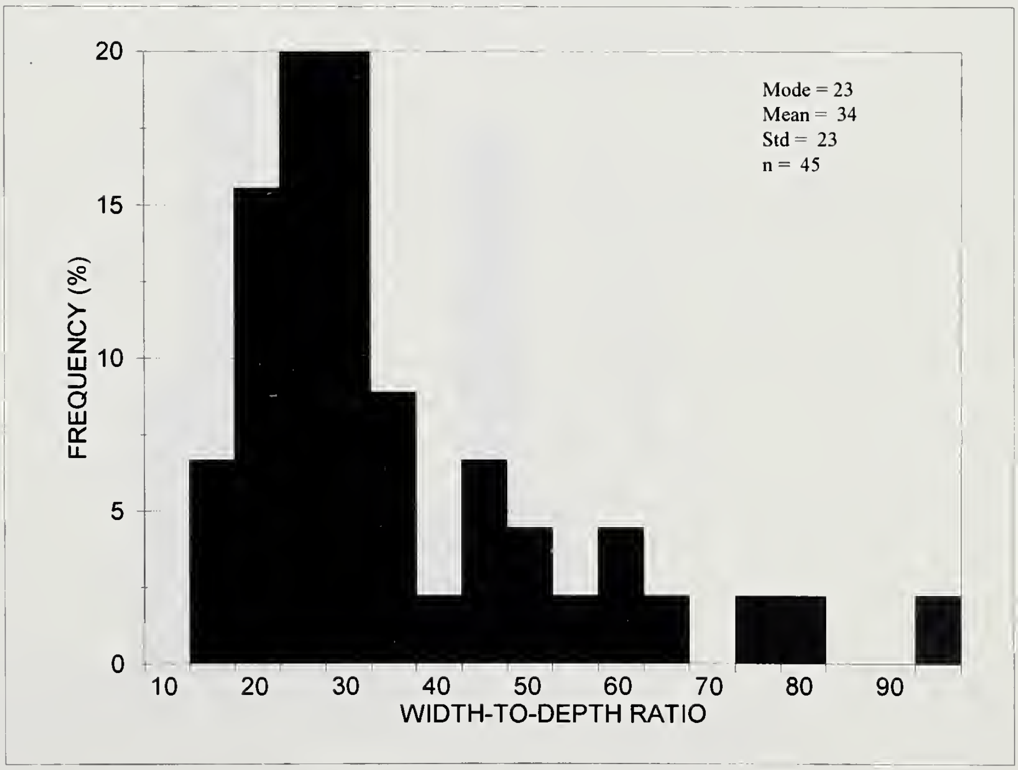

Figure 94—Frequency distribution displaying the range of width-to-depth ratios for "C" channel sedimentary stream reaches.

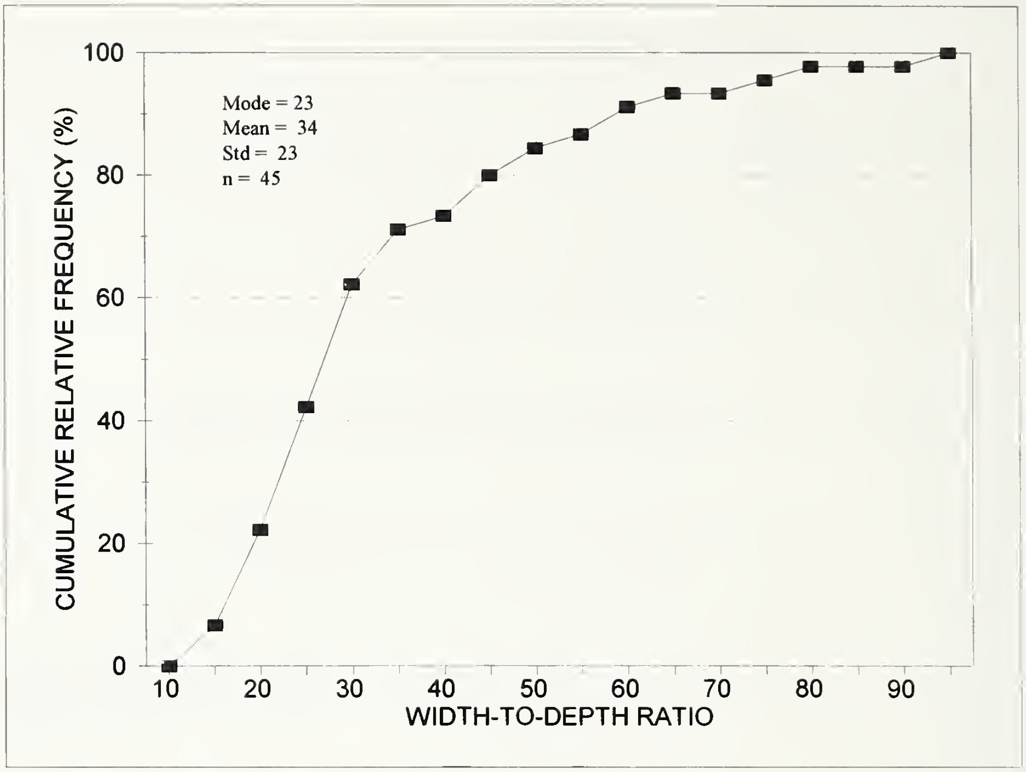

Figure 95—Cumulative relative frequency distribution displaying the range of width-to-depth ratios for "C" channel sedimentary stream reaches.

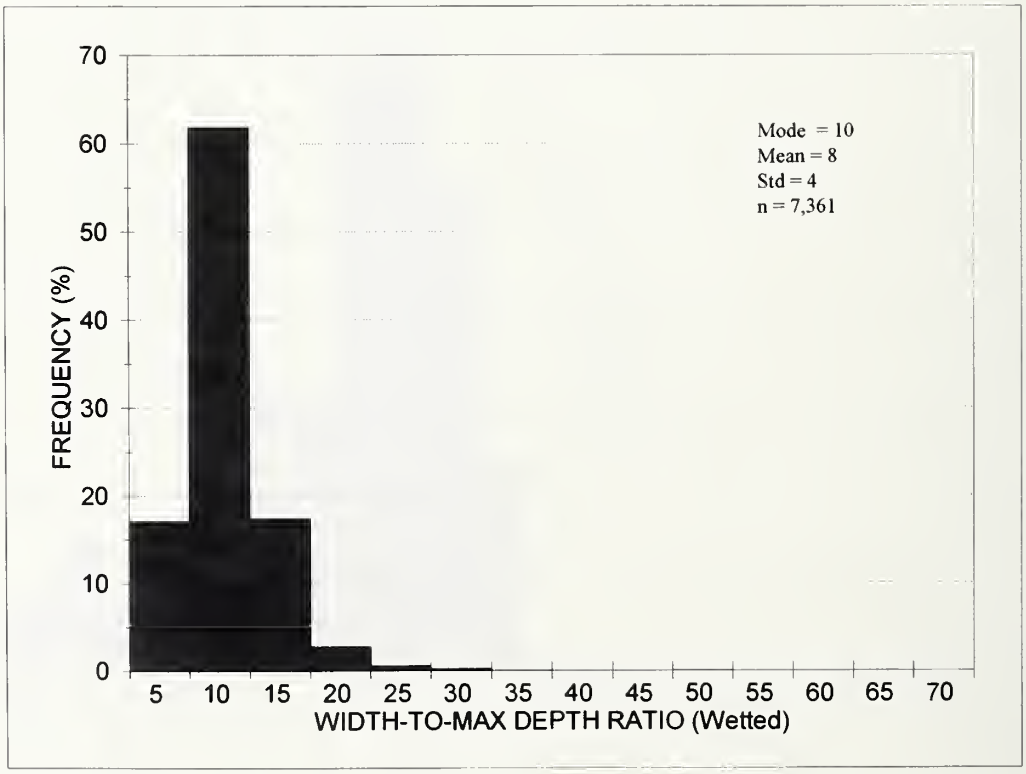

Figure 96—Frequency distribution displaying the range of width-to-maximum-depth ratios for all channel reach types.

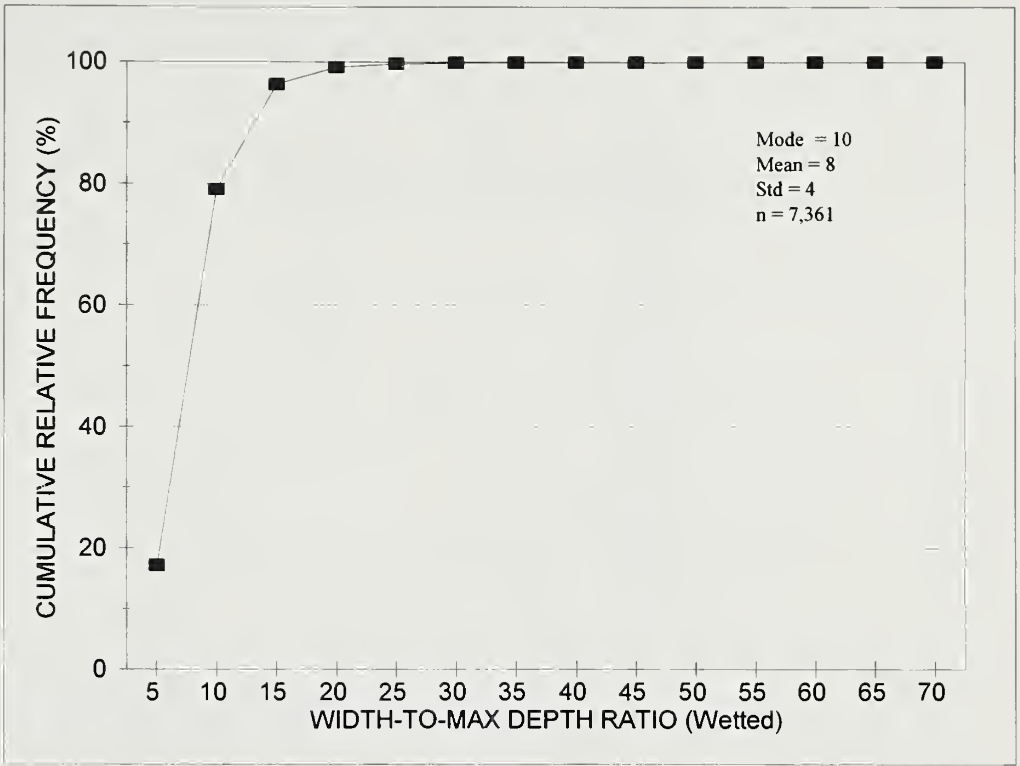

Figure 97—Cumulative relative frequency distribution displaying the range of width-to-maximum-depth ratios for all channel reach types.

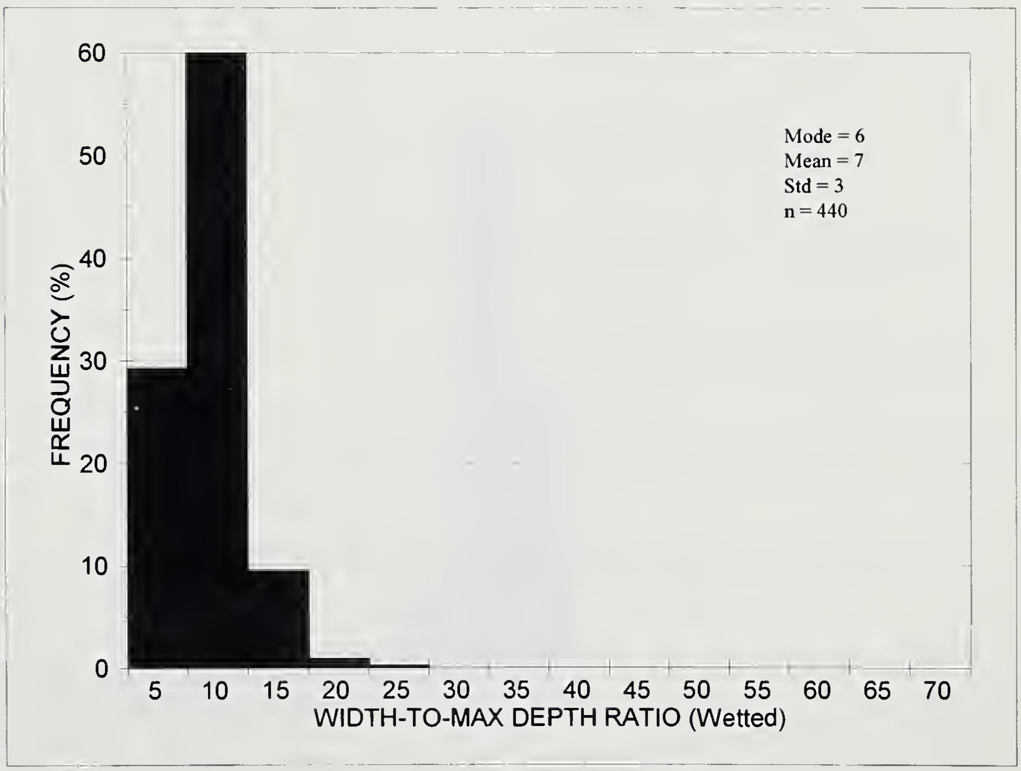

Figure 98—Frequency distribution displaying the range of width-to-maximum-depth ratios for "A" channel reach types.

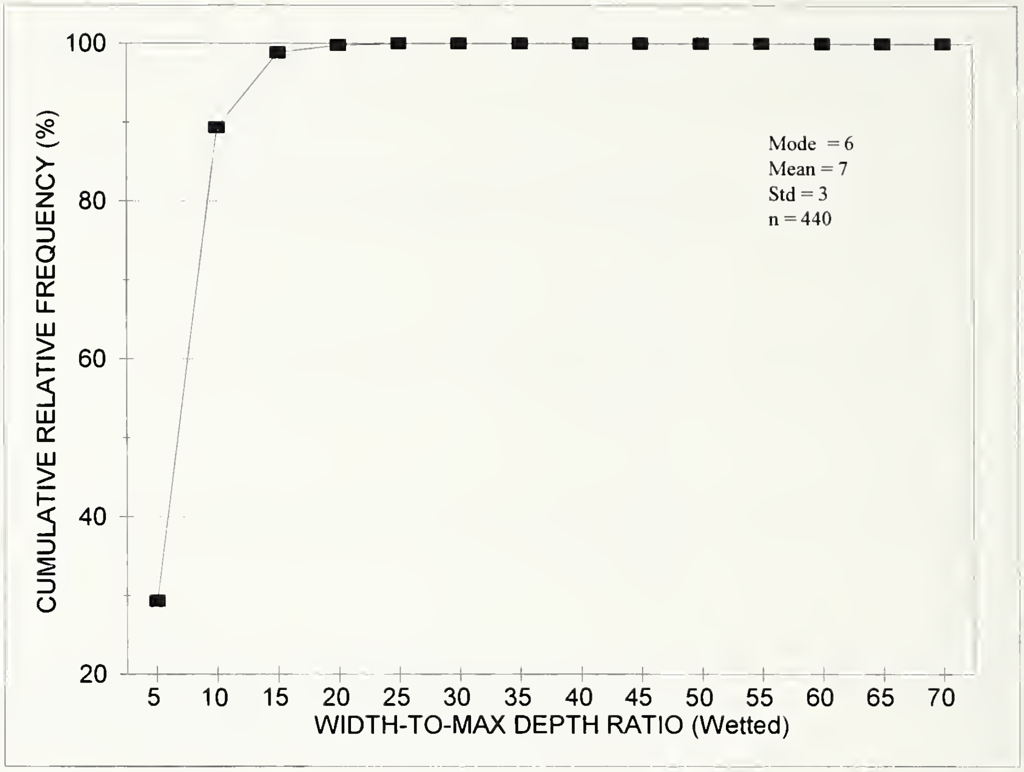

Figure 99—Cumulative relative frequency distribution displaying the range of width-to-maximum-depth ratios for "A" channel reach types.

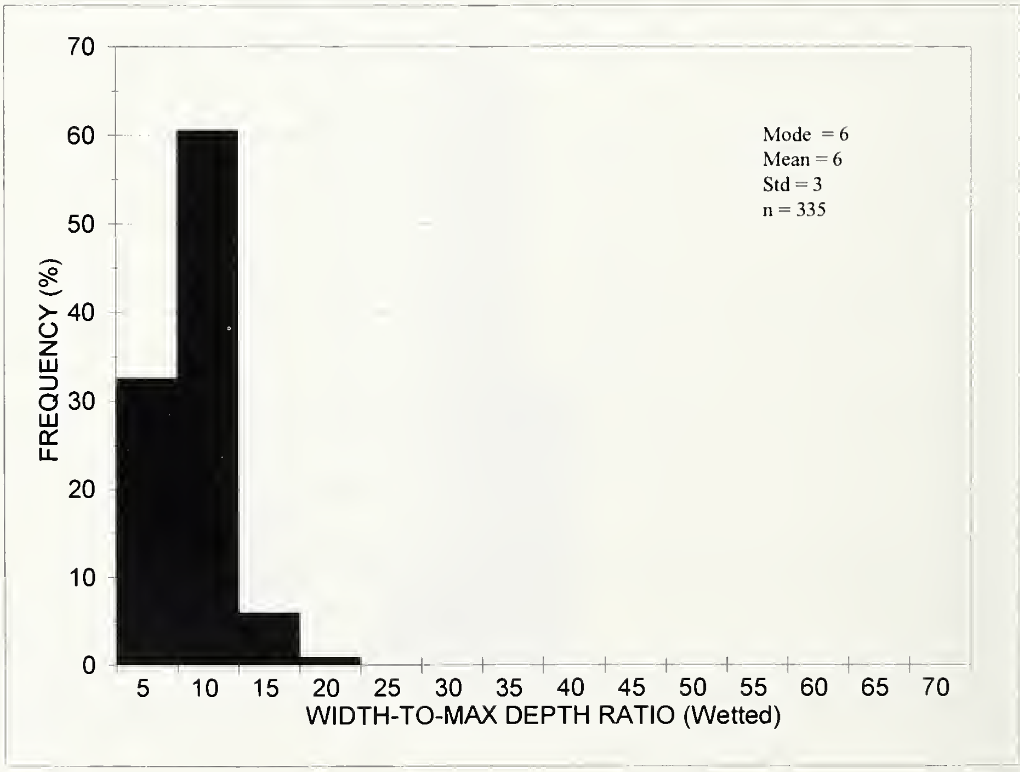

Figure 100—Frequency distribution displaying the range of width-to-maximum-depth ratios for "A" channel plutonic stream reaches.

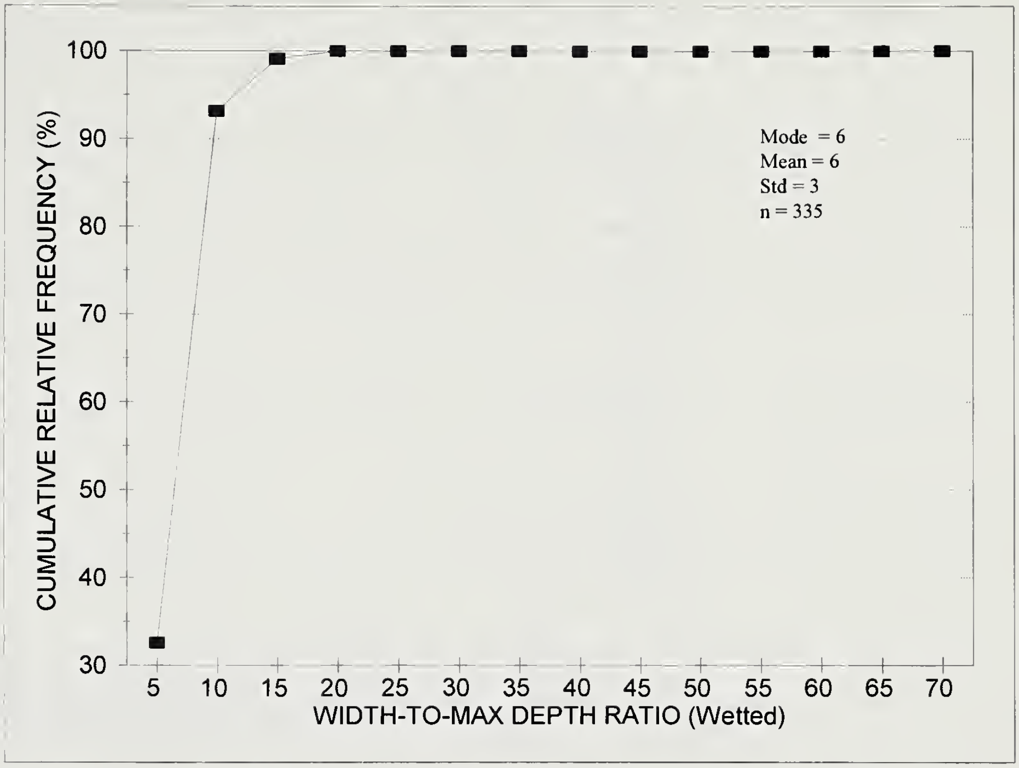

Figure 101—Cumulative relative frequency distribution displaying the range of width-to-maximum-depth ratios for "A" channel plutonic stream reaches.

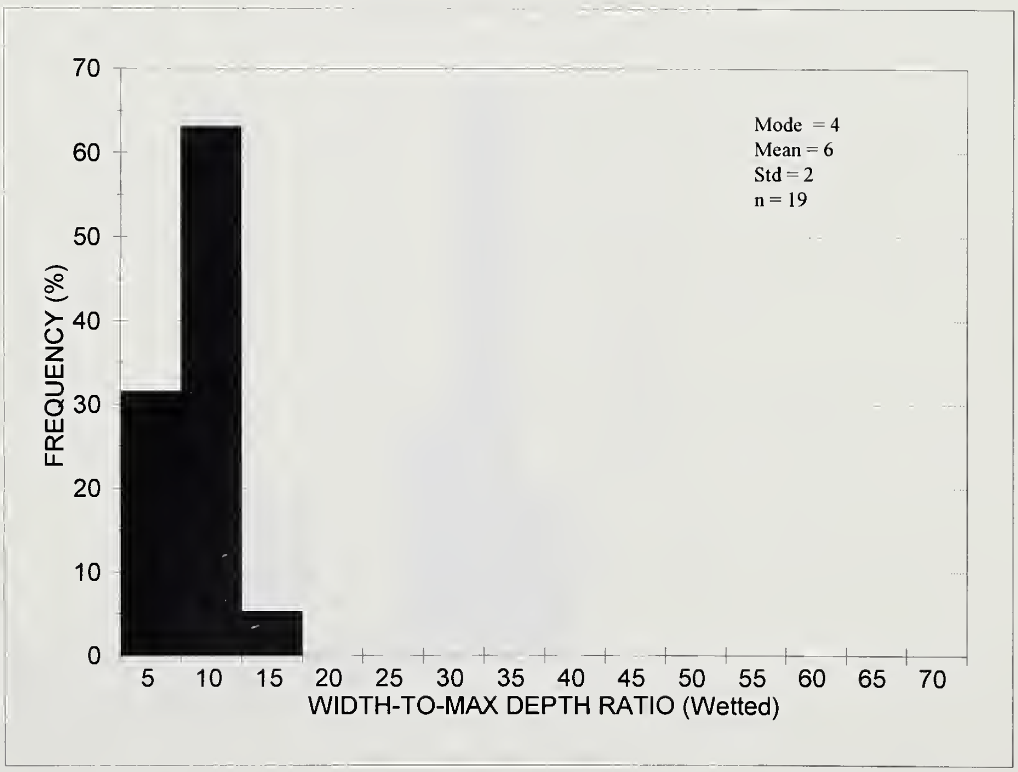

Figure 102—Frequency distribution displaying the range of width-to-maximum-depth ratios for "A" channel volcanic stream reaches.

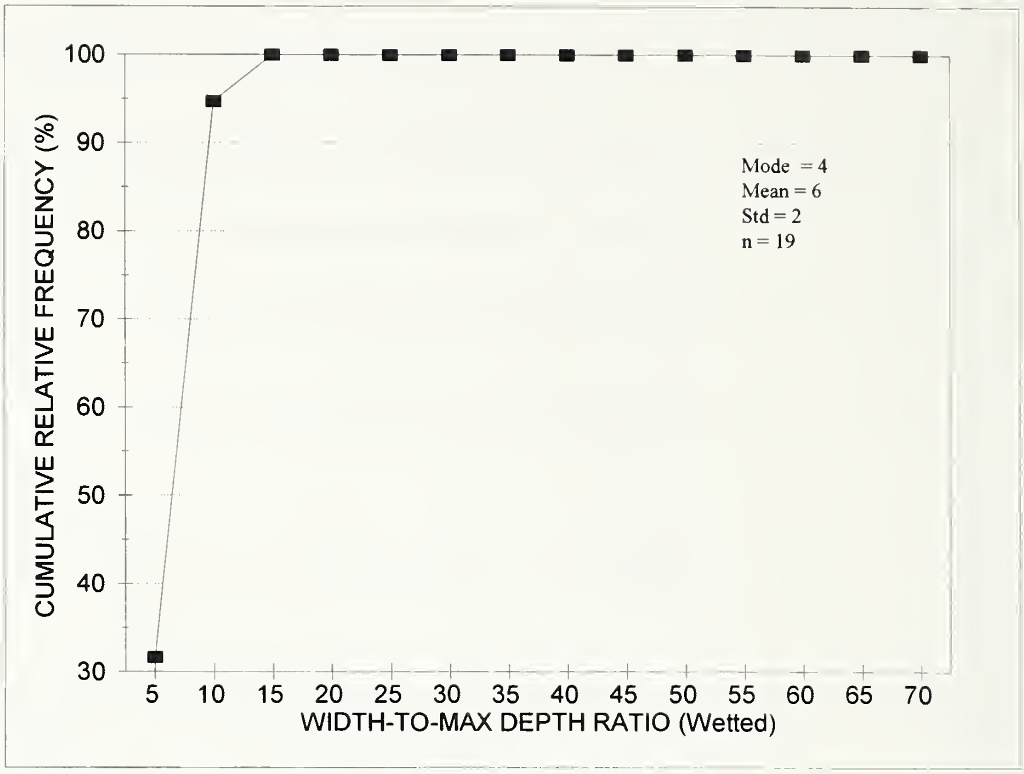

Figure 103—Cumulative relative frequency distribution displaying the range of width-to-maximum-depth ratios for "A" channel volcanic stream reaches.

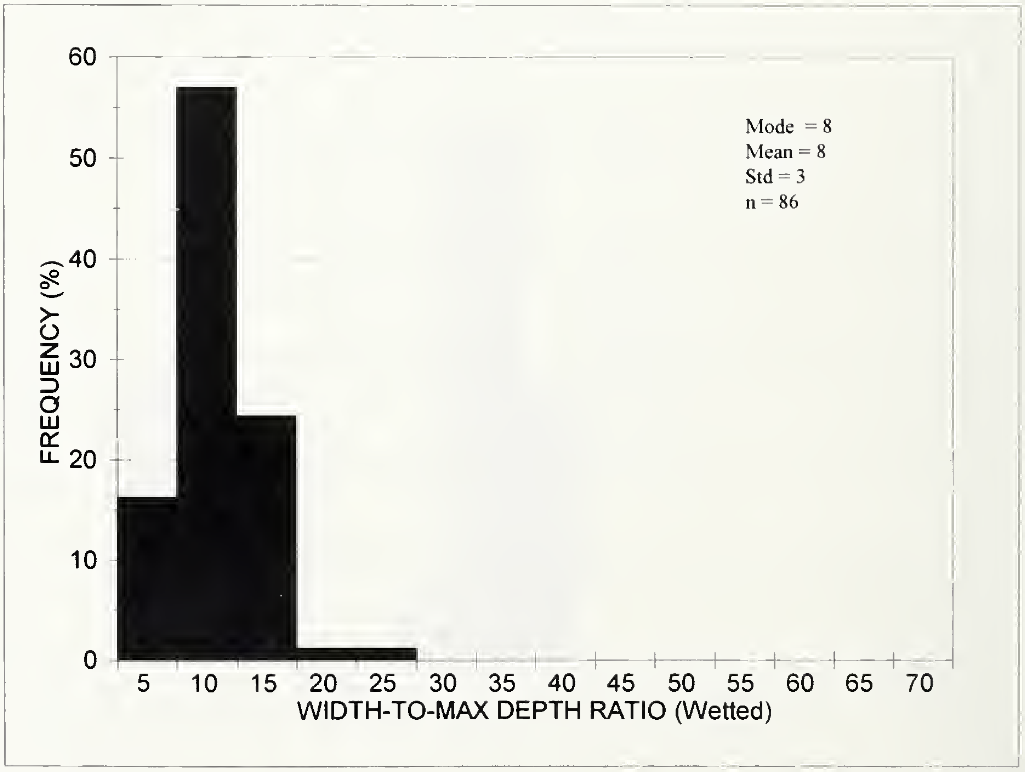

Figure 104—Frequency distribution displaying the range of width-to-maximum-depth ratios for "A" channel metamorphic stream reaches.

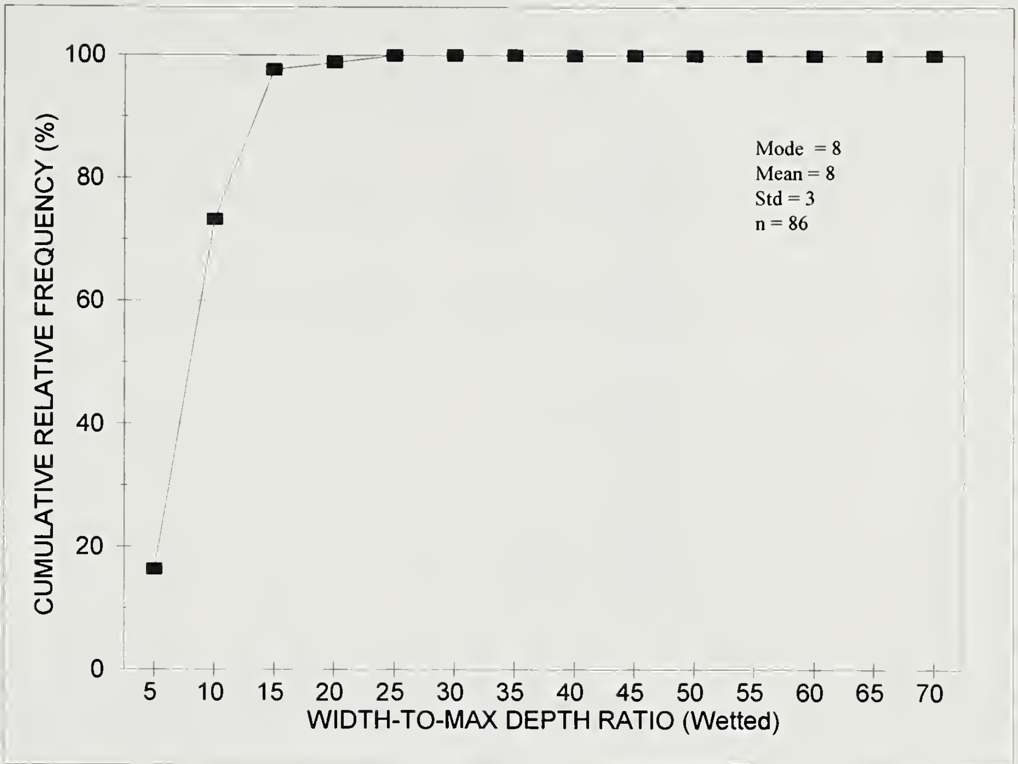

Figure 105—Cumulative relative frequency distribution displaying the range of width-to-maximum-depth ratios for "A" channel metamorphic stream reaches.

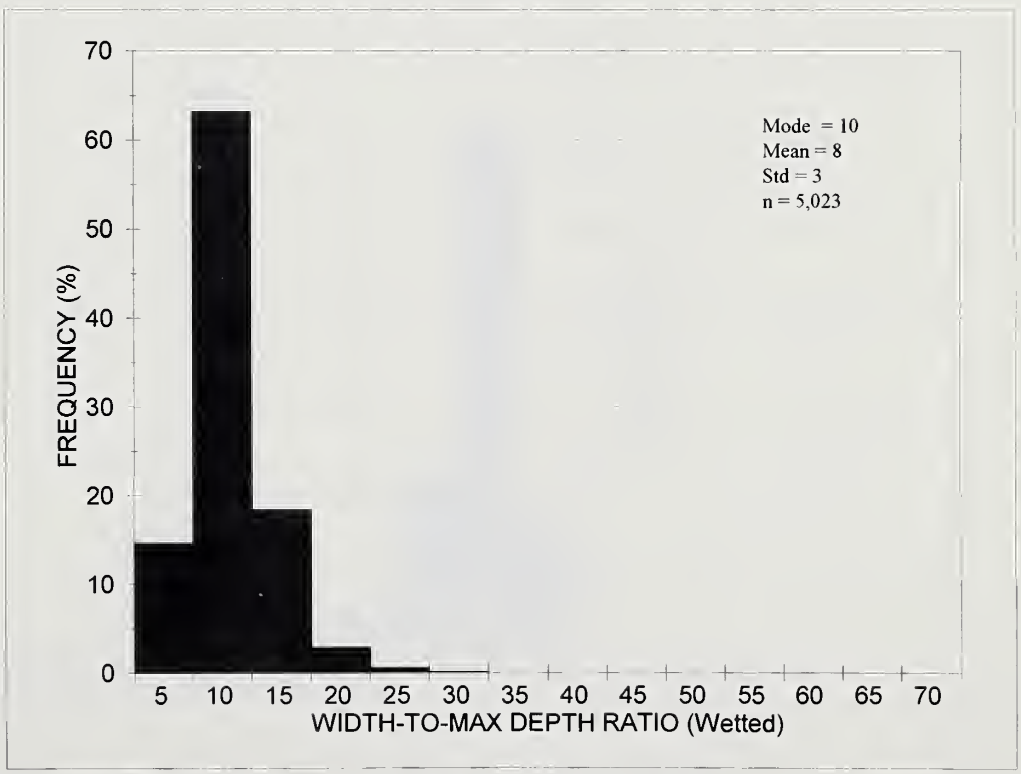

Figure 106—Frequency distribution displaying the range of width-to-maximum-depth ratios for "B" channel reach types.

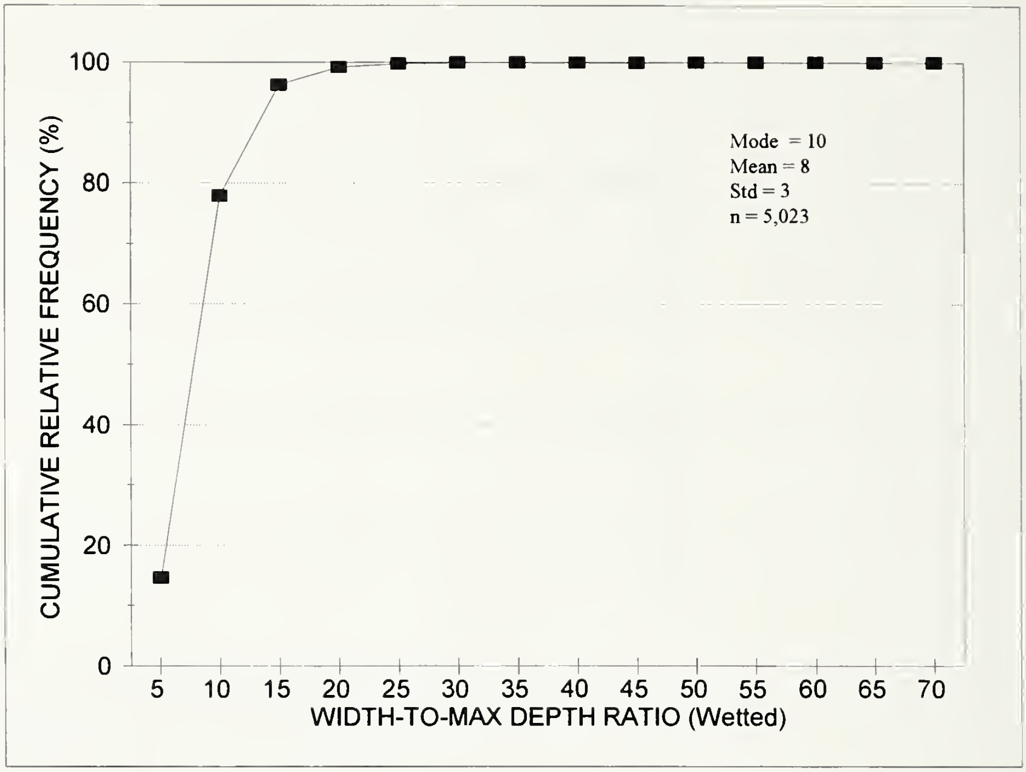

Figure 107—Cumulative relative frequency distribution displaying the range of width-to-maximum-depth ratios for "B" channel reach types.

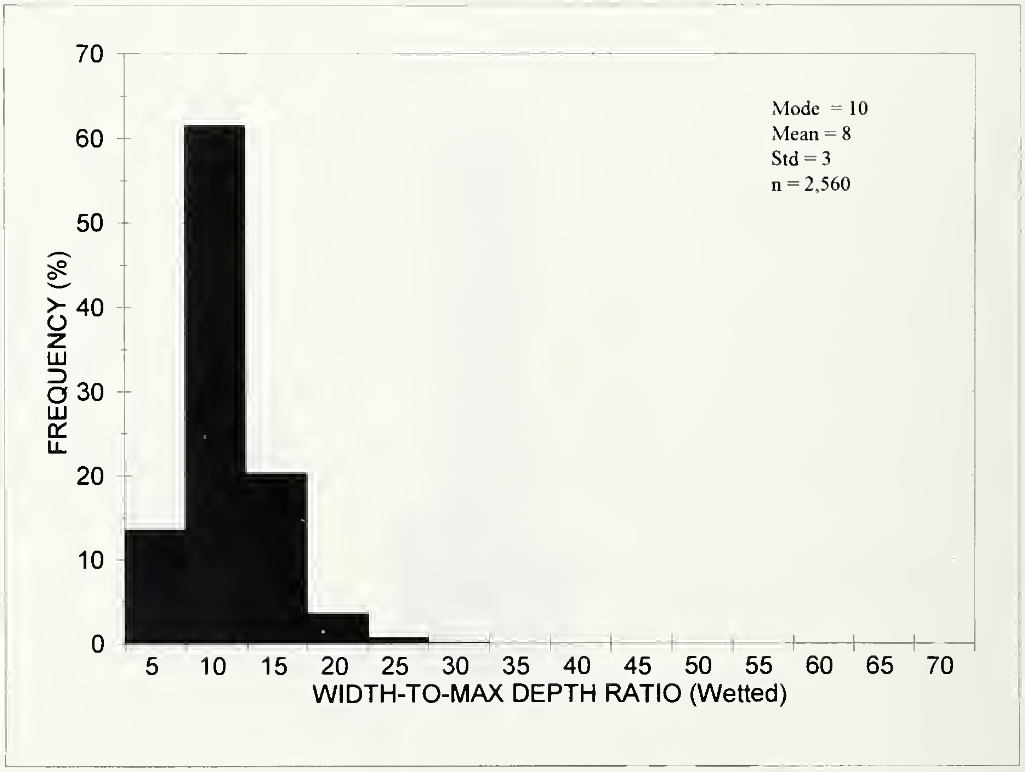

Figure 108—Frequency distribution displaying the range of width-to-maximum-depth ratios for "B" channel plutonic stream reaches.

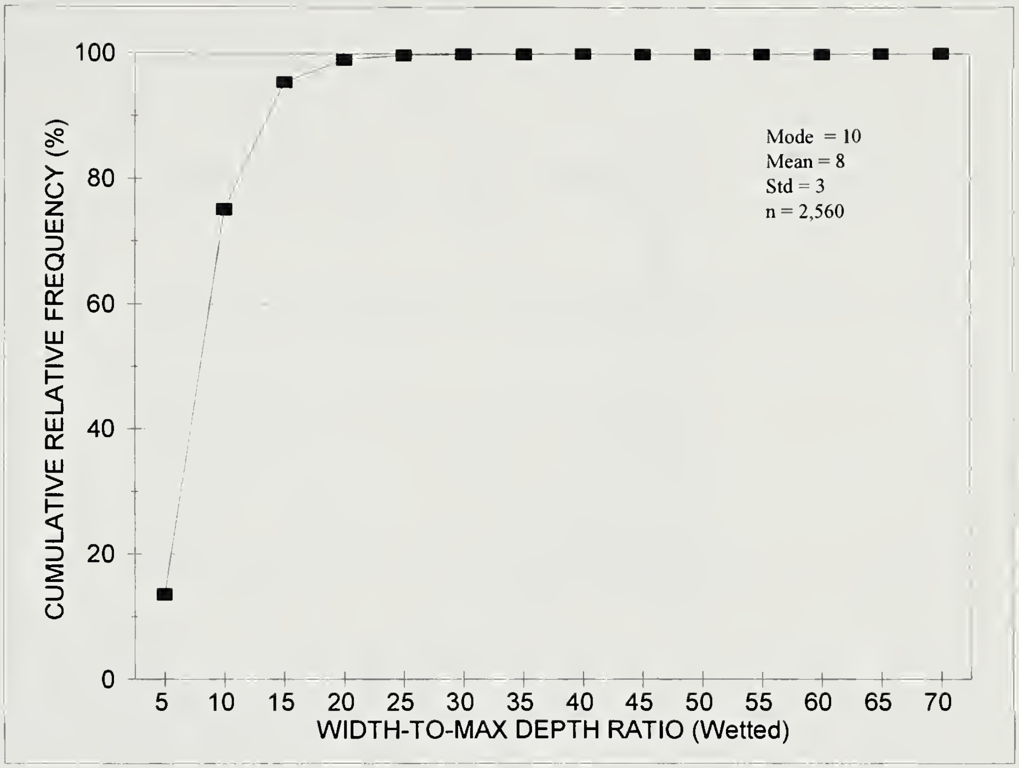

Figure 109—Cumulative relative frequency distribution displaying the range of width-to-maximum-depth ratios for "B" channel plutonic stream reaches.

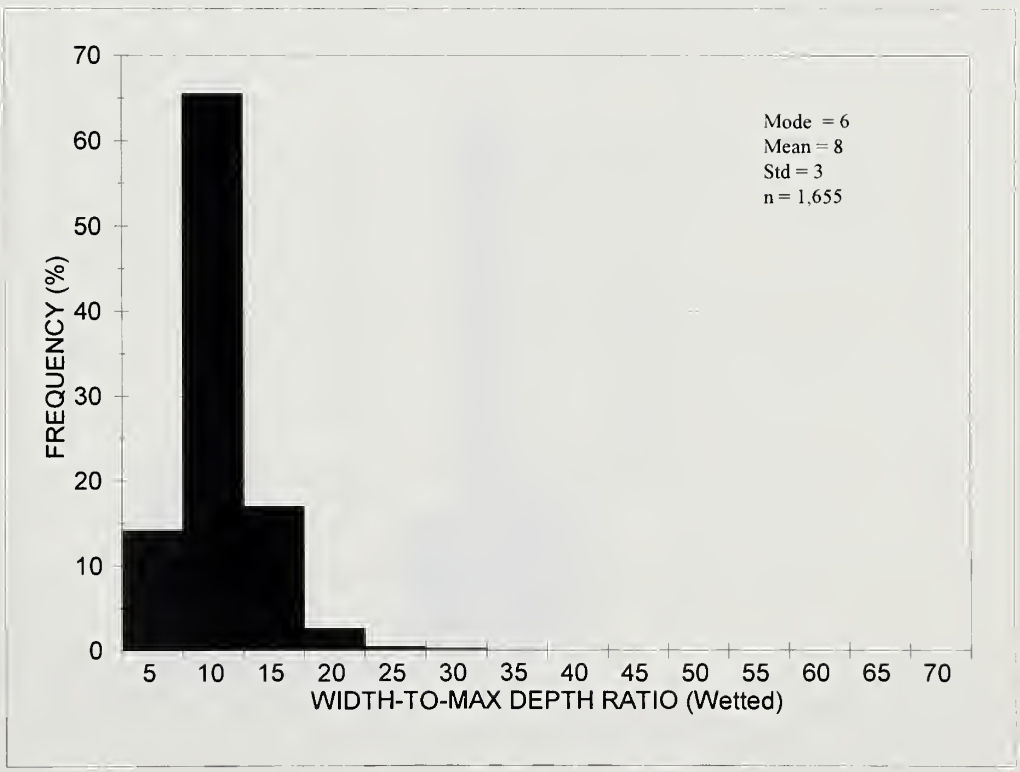

Figure 110—Frequency distribution displaying the range of width-to-maximum-depth ratios for "B" channel volcanic stream reaches.

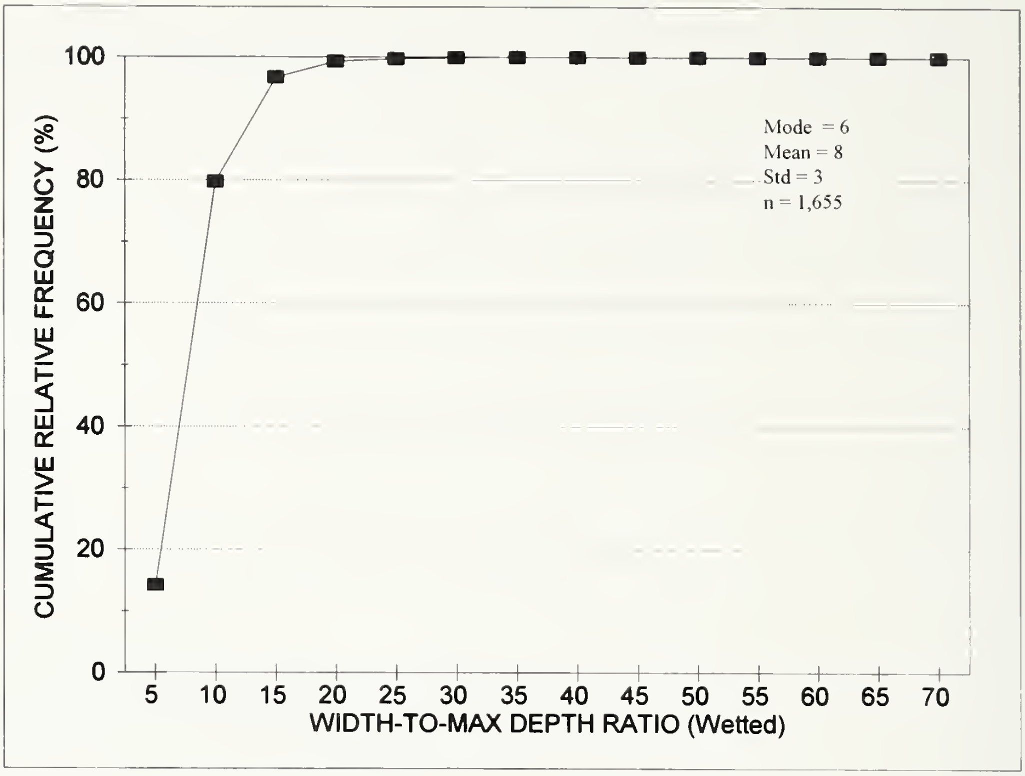

Figure 111—Cumulative relative frequency distribution displaying the range of width-to-maximum-depth ratios for "B" channel volcanic stream reaches.

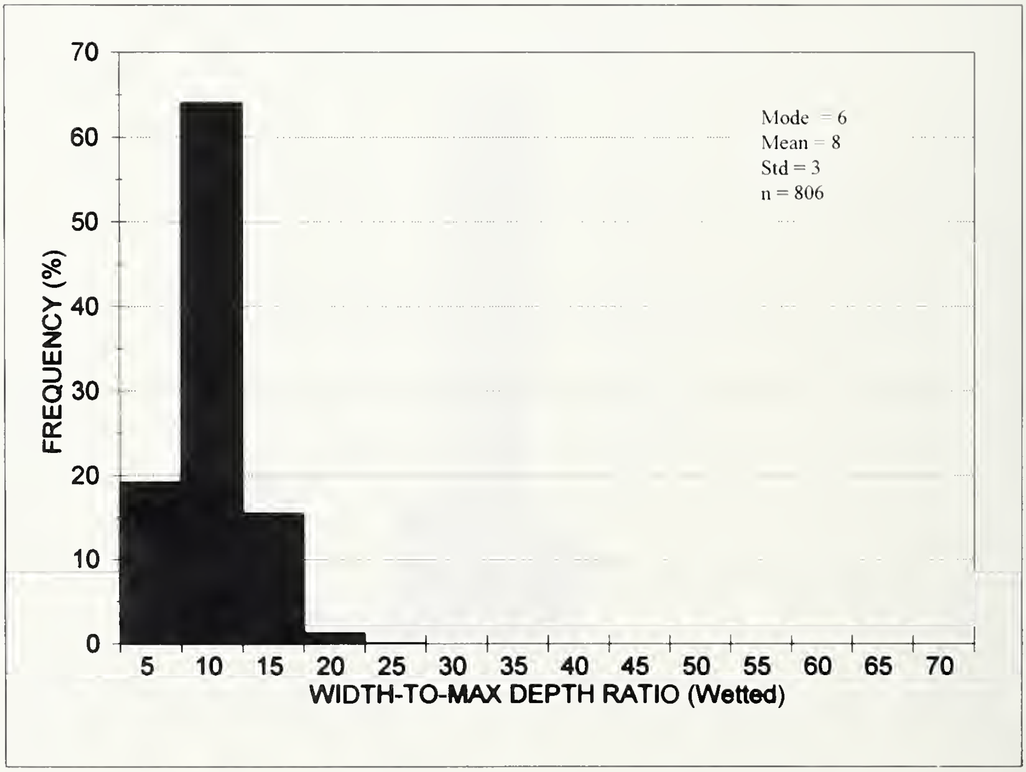

Figure 112—Frequency distribution displaying the range of width-to-maximum-depth ratios for "B" channel metamorphic stream reaches.

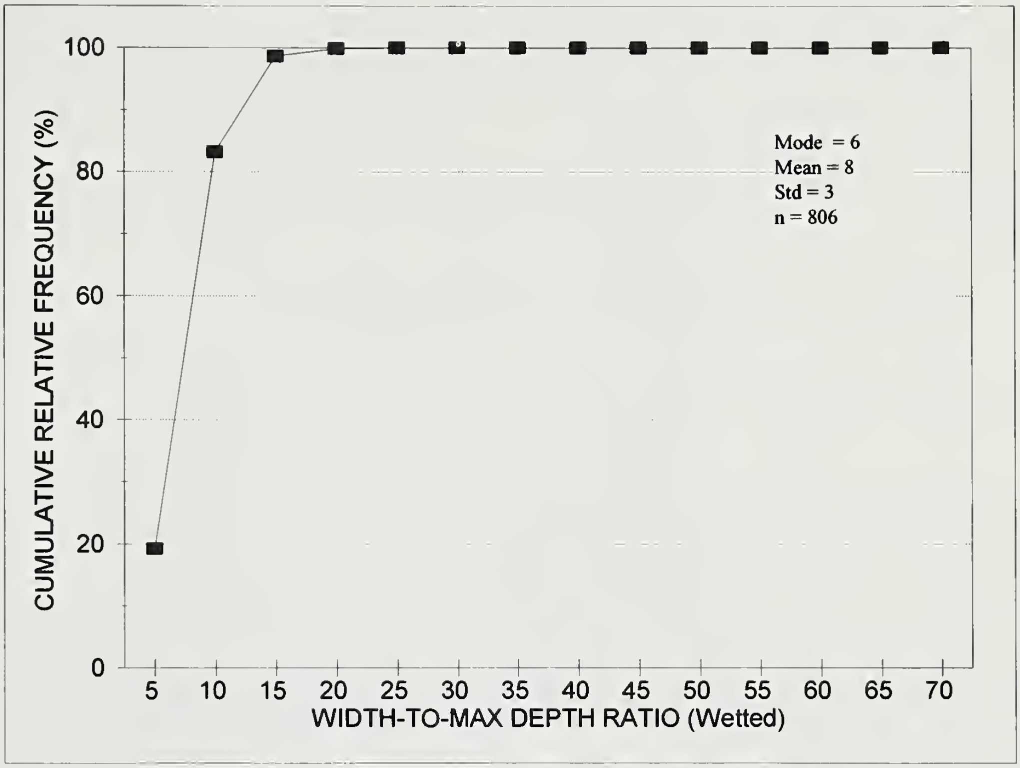

Figure 113—Cumulative relative frequency distribution displaying the range of width-to-maximum-depth ratios for "B" channel metamorphic stream reaches.

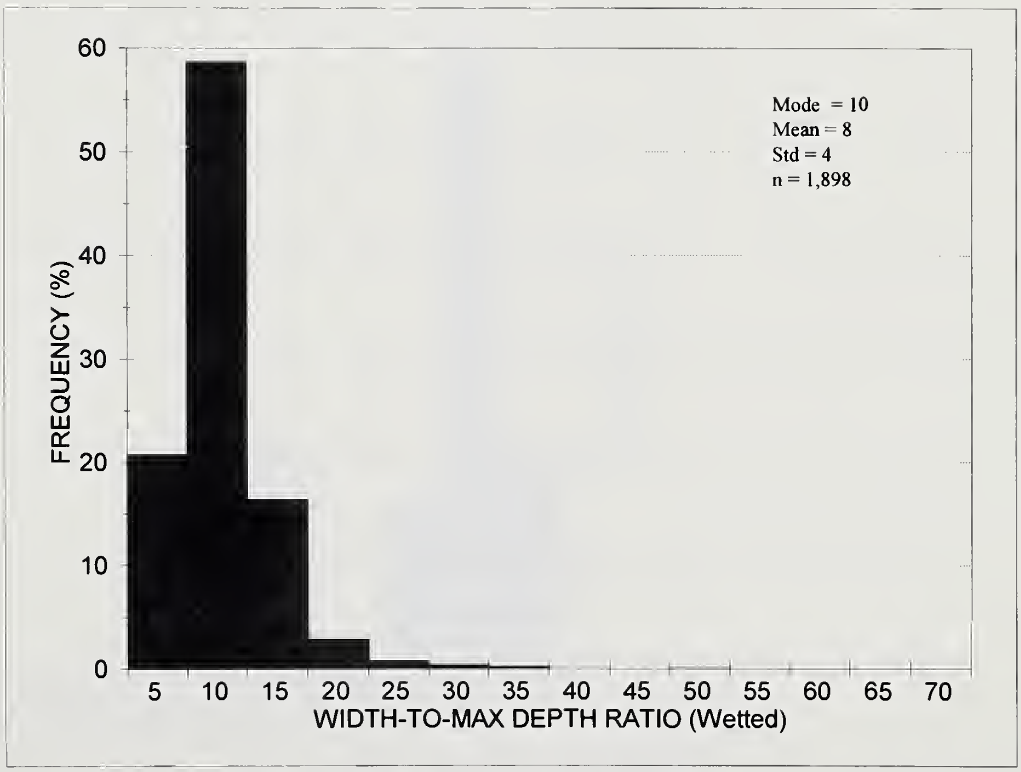

Figure 114—Frequency distribution displaying the range of width-to-maximum-depth ratios for "C" channel reach types.

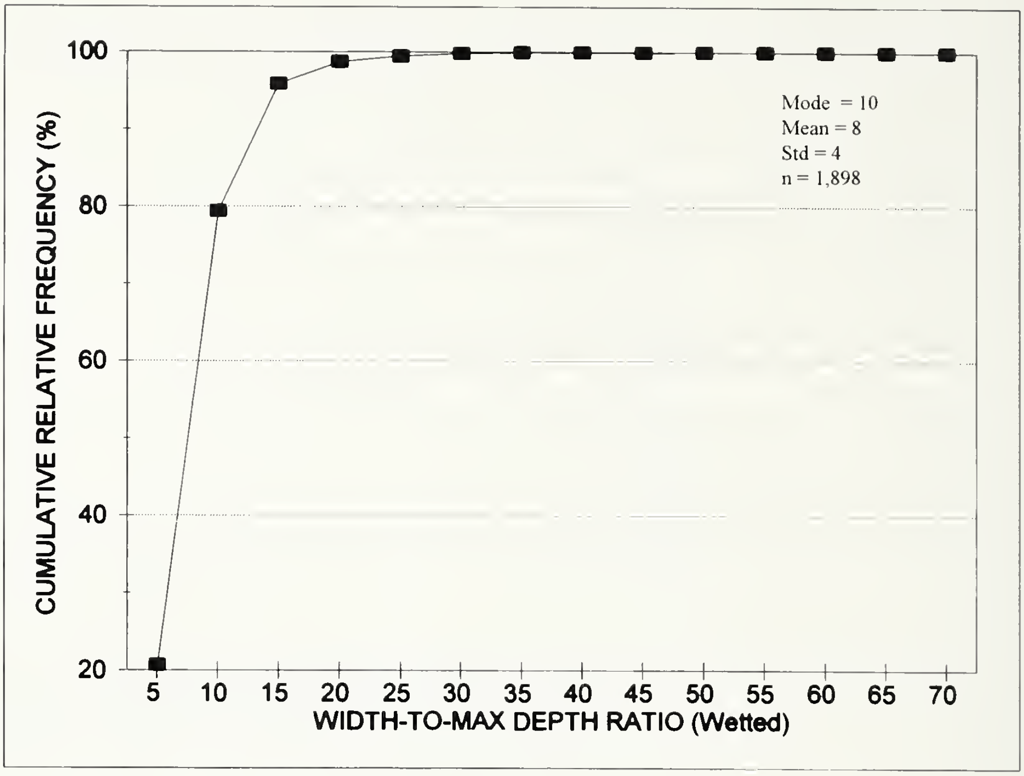

Figure 115—Cumulative relative frequency distribution displaying the range of width-to-maximum-depth ratios for "C" channel reach types.

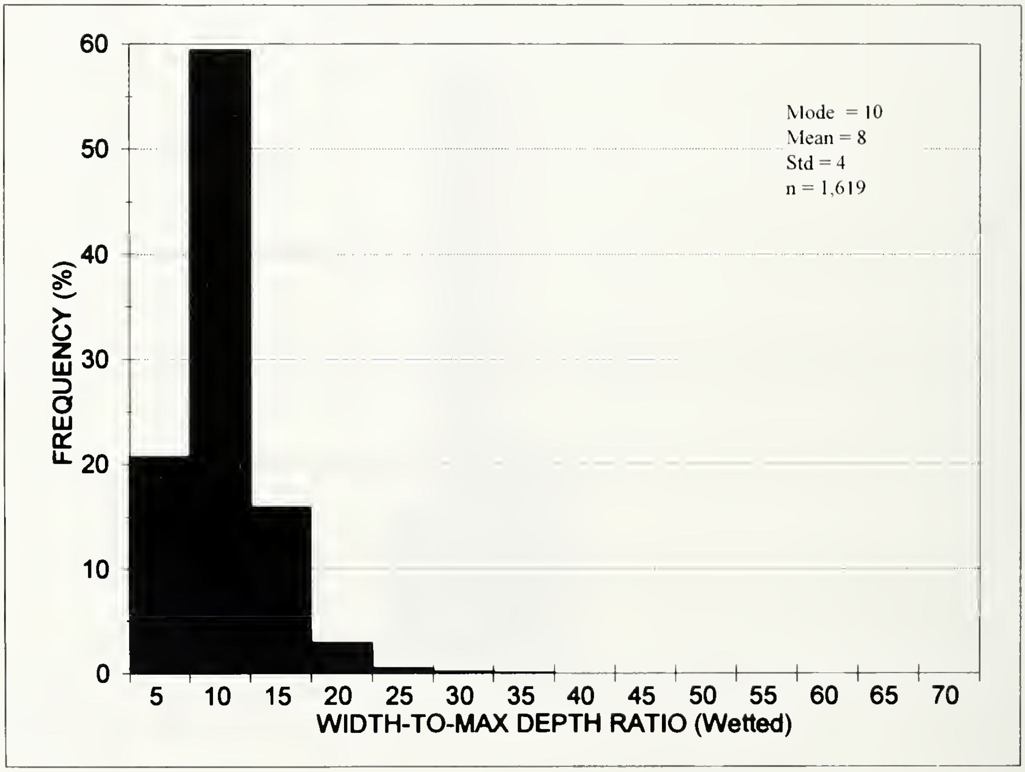

Figure 116—Frequency distribution displaying the range of width-to-maximum-depth ratios for "C" channel plutonic stream reaches.

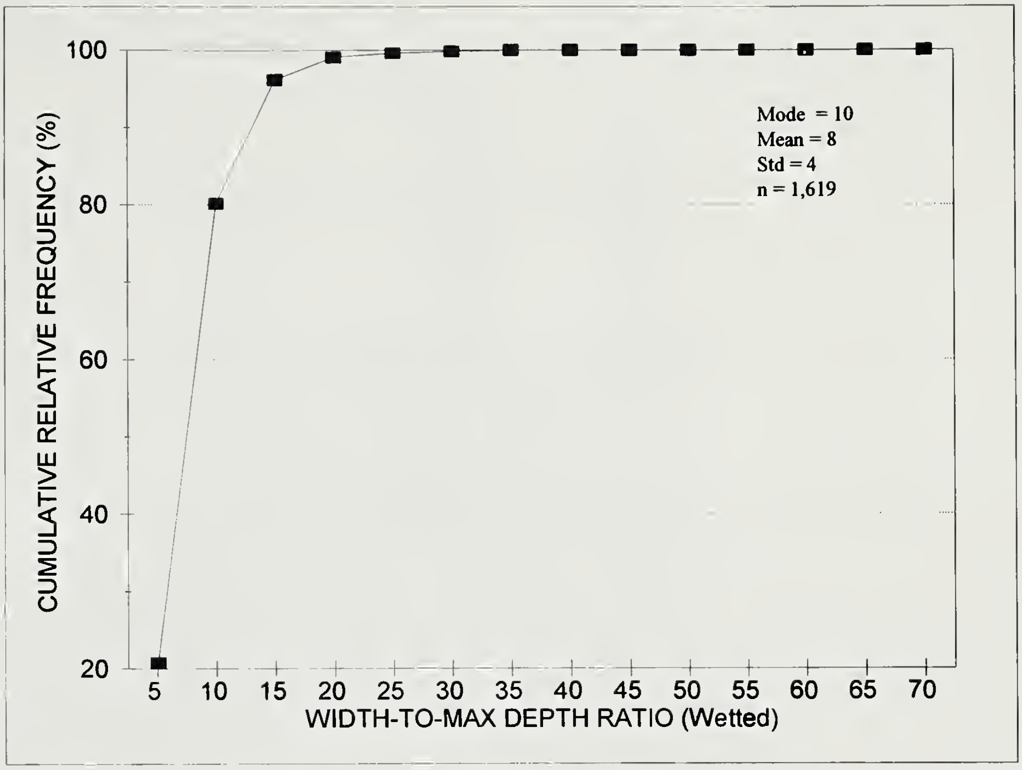

Figure 117—Cumulative relative frequency distribution displaying the range of width-to-maximum-depth ratios for "C" channel plutonic stream reaches.

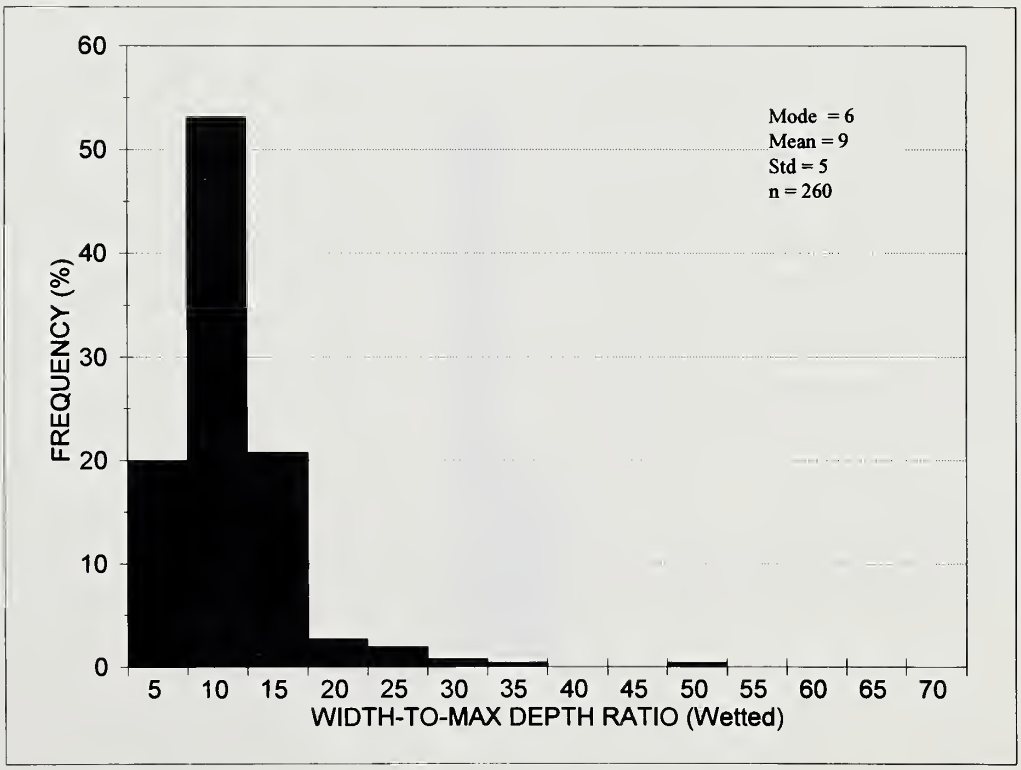

Figure 118—Frequency distribution displaying the range of width-to-maximum-depth ratios for "C" channel volcanic stream reaches.

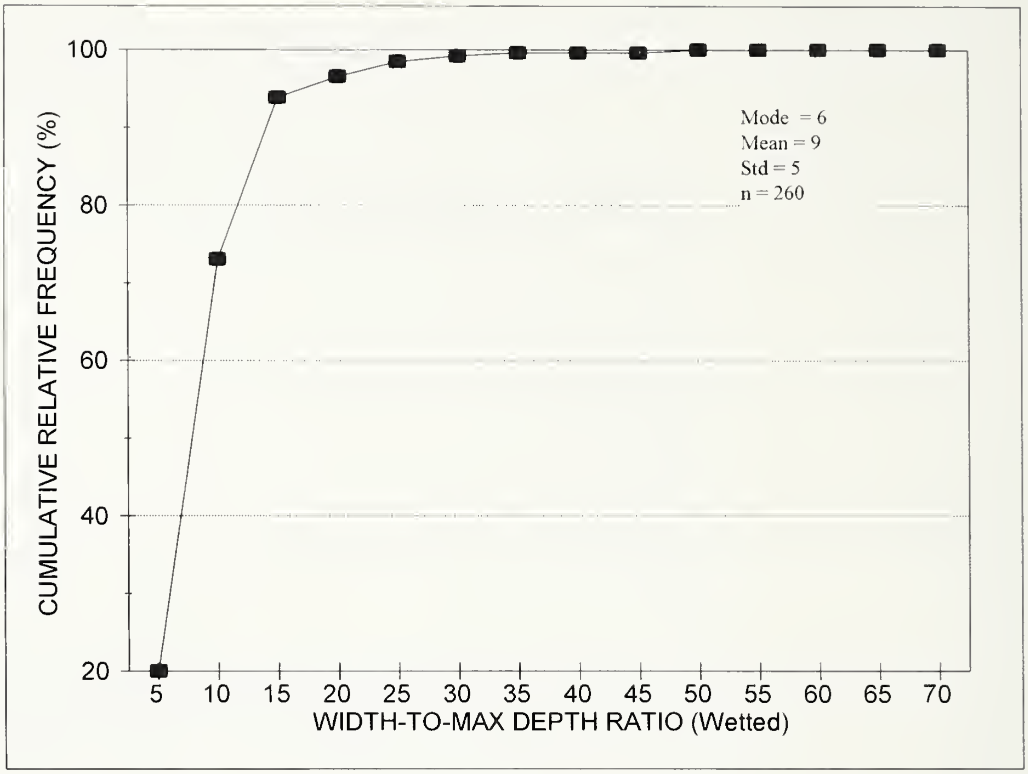

Figure 119—Cumulative relative frequency distribution displaying the range of width-to-maximum-depth ratios for "C" channel volcanic stream reaches.

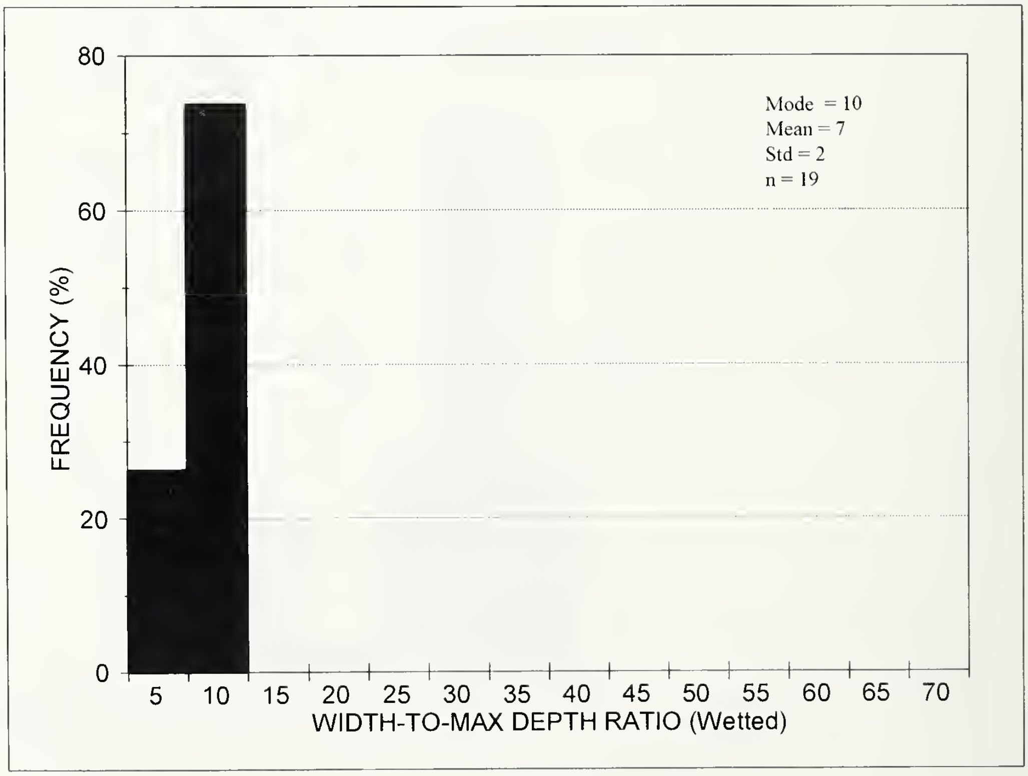

Figure 120—Frequency distribution displaying the range of width-to-maximum-depth ratios for "C" channel sedimentary stream reaches.

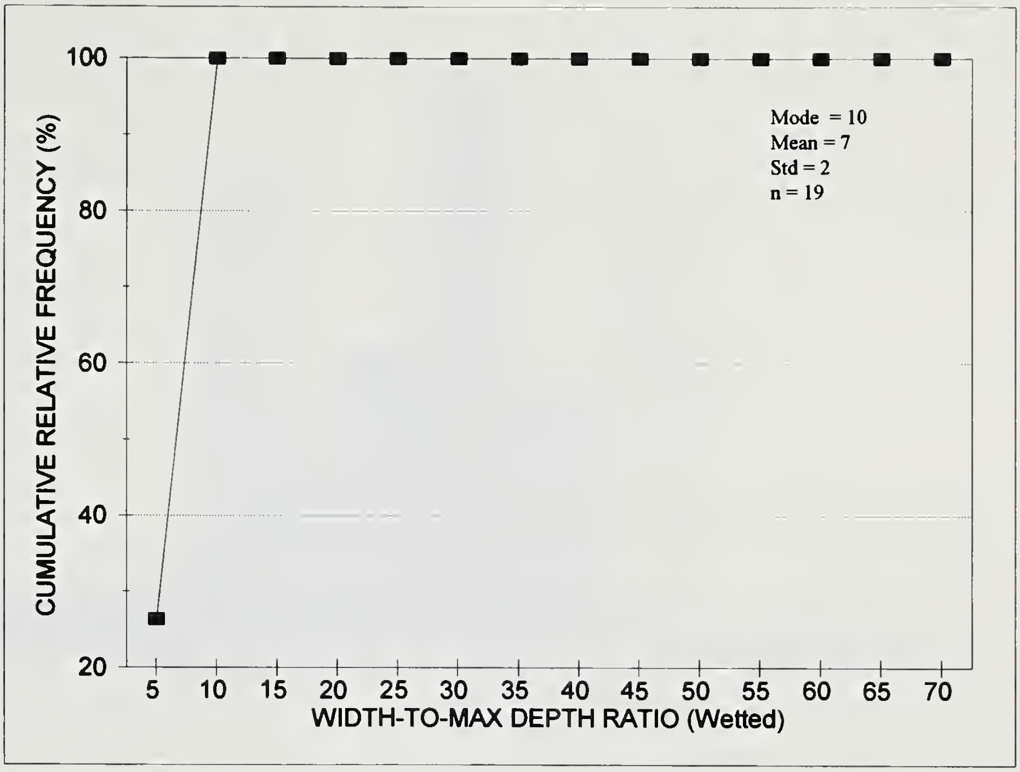

Figure 121—Cumulative relative frequency distribution displaying the range of width-to-maximum-depth ratios for "C" channel sedimentary stream reaches.

Surface Fines

Surface fines for this analysis refer to inorganic particles less than 6 mm in size (silt/sand). These particles can be transported either as suspended sediment or as bedload. Scour and deposition rates and patterns of fine sediment are dependent on sediment load, discharge, slope, and channel morphology (Meehan 1991). Sediment of this size is generally transported during peak flows and settles out on the downside of the peak in low-velocity areas after coarse sediments have been deposited. This results in blanketing of pool bottoms and low gradient riffles. If large amounts are present, fines can fill pools and deposit around channel features smoothing out the bed, resulting in reduced spatial variability. Numerous studies document the increases of inchannel sediment resulting from land-disturbing activities (see Everest and others 1987 and Meehan 1991 for detailed discussions and references).

The percent surface fines is visually estimated only in pool tails (exclude dammed pools and step pool complexes) and low gradient riffle habitat types. Figures 122 through 147 are the statistical summaries for percent surface fines grouped by all surveyed stream reaches, by channel reach types, and by channel reach types and geology.

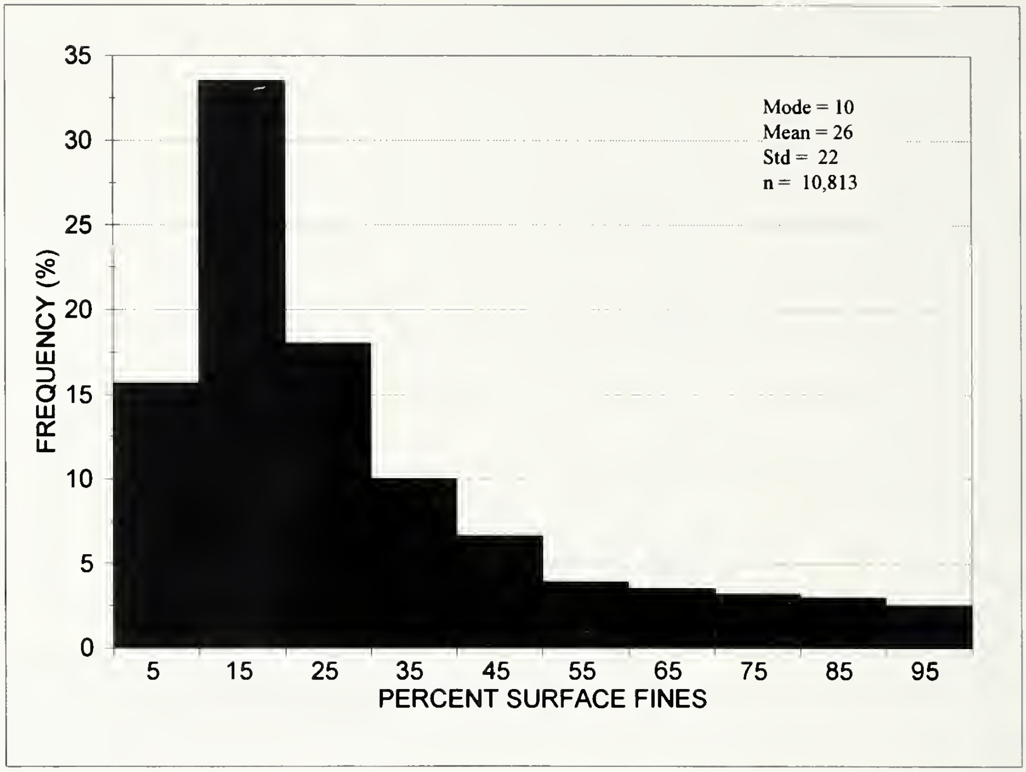

Figure 122—Frequency distribution displaying the range of percent surface fines for all channel reach types.

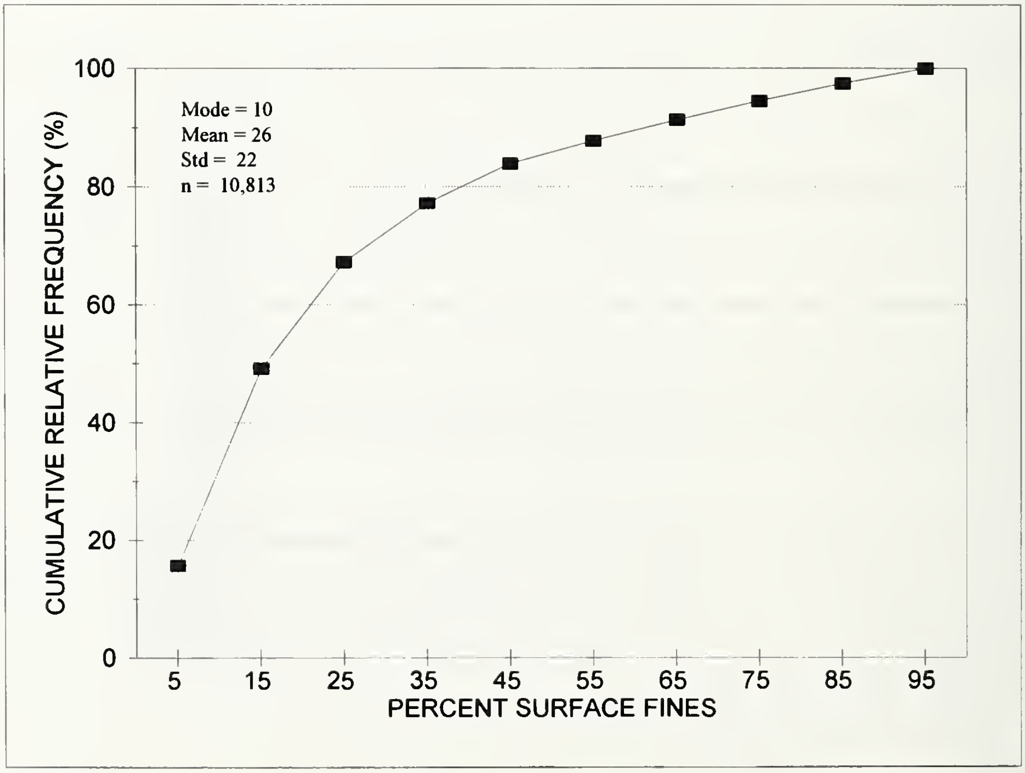

Figure 123—Cumulative relative frequency distribution displaying the range of percent surface fines for all channel reach types.

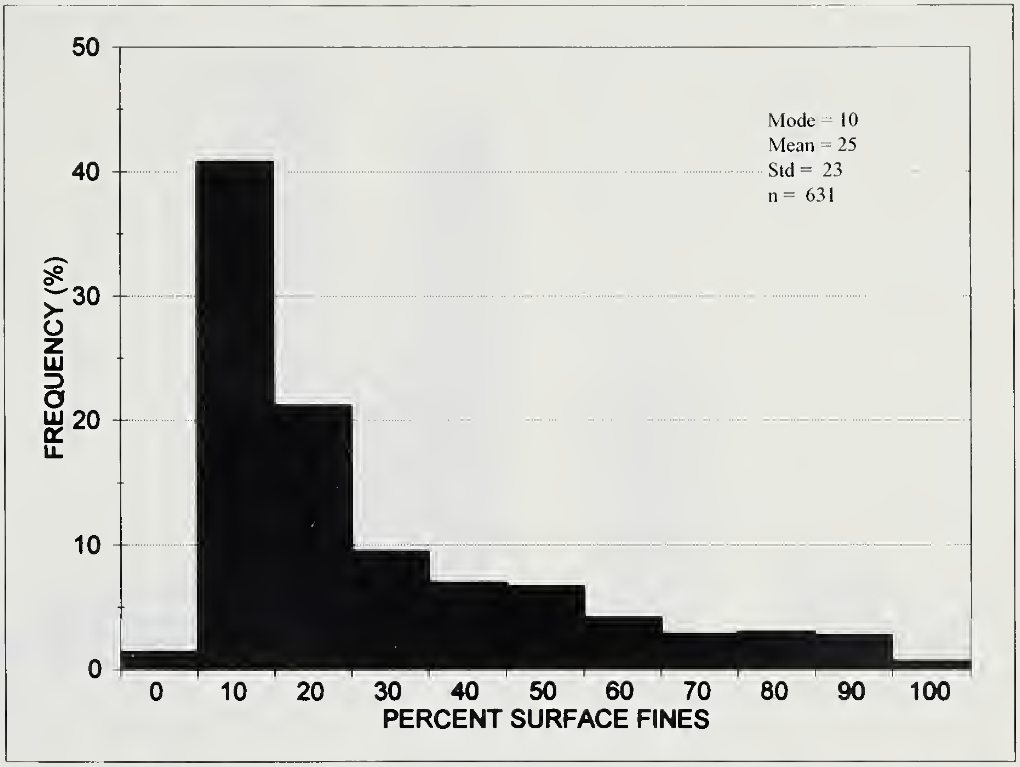

Figure 124—Frequency distribution displaying the range of percent surface fines for "A" channel reach types.

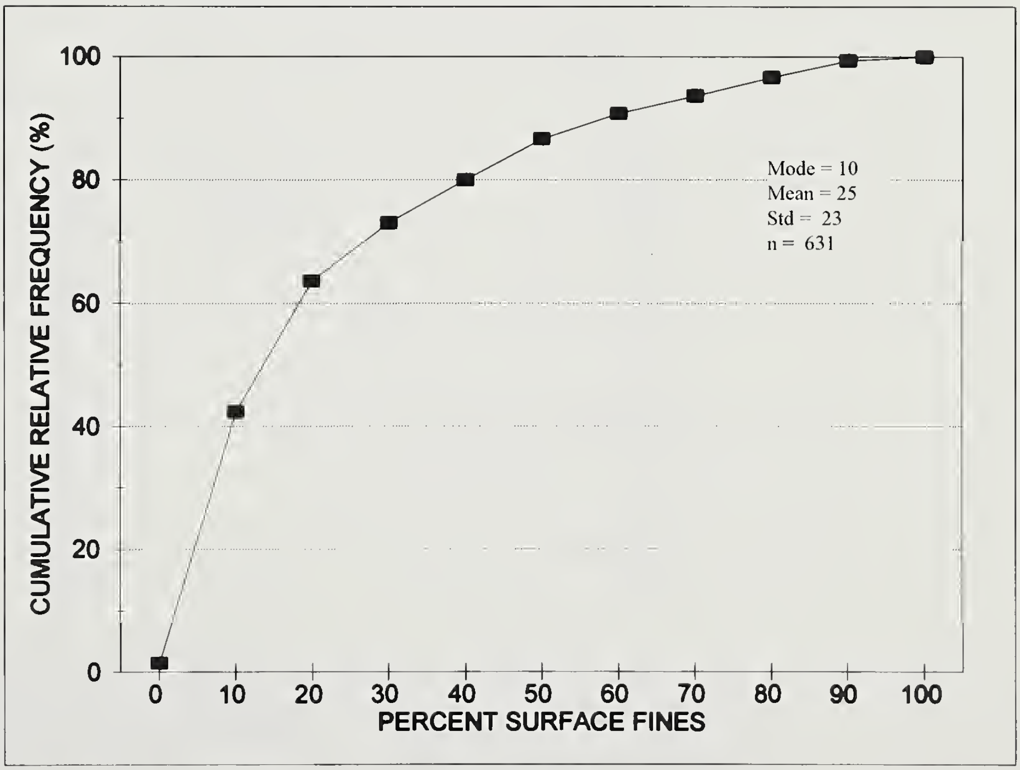

Figure 125—Cumulative relative frequency distribution displaying the range of percent surface fines for "A" channel reach types.

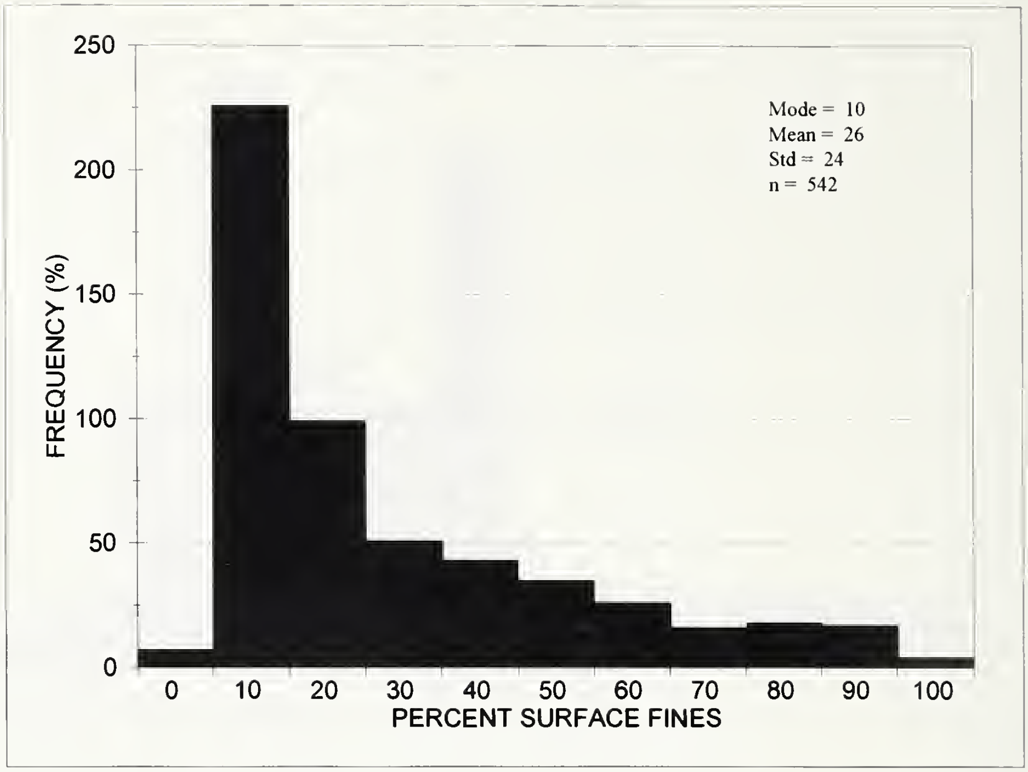

Figure 126—Frequency distribution displaying the range of percent surface fines for "A" channel plutonic stream reaches.

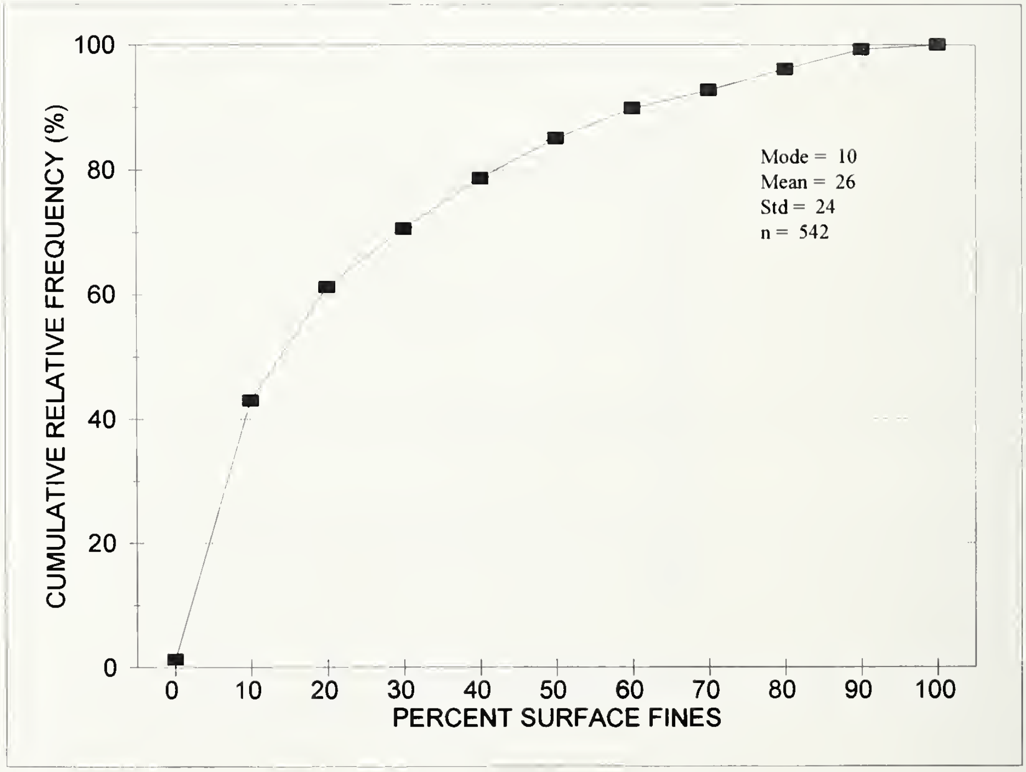

Figure 127—Cumulative relative frequency distribution displaying the range of percent surface fines for "A" channel plutonic stream reaches.

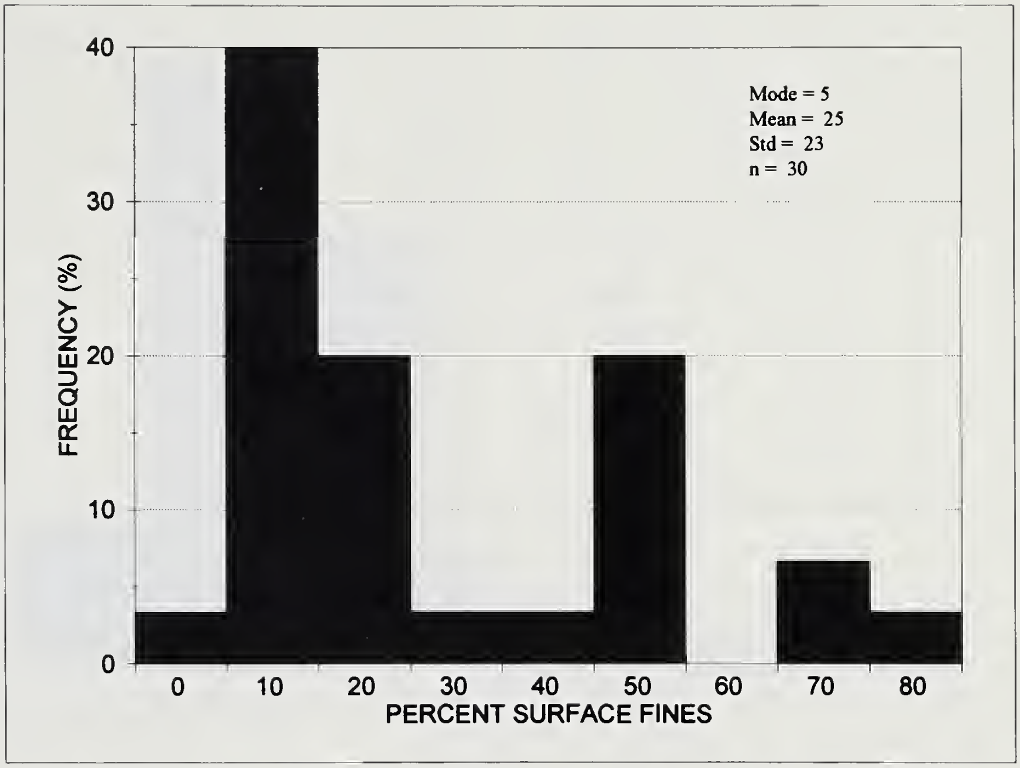

Figure 128—Frequency distribution displaying the range of percent surface fines for "A" channel volcanic stream reaches.

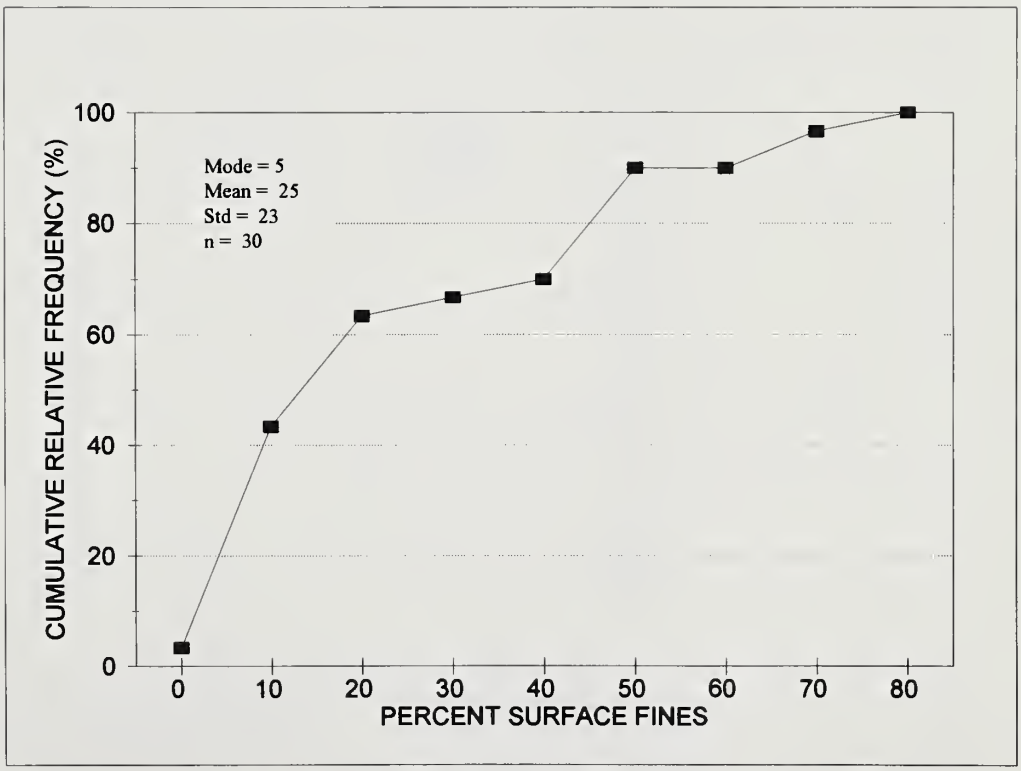

Figure 129—Cumulative relative frequency distribution displaying the range of percent surface fines for "A" channel volcanic stream reaches.

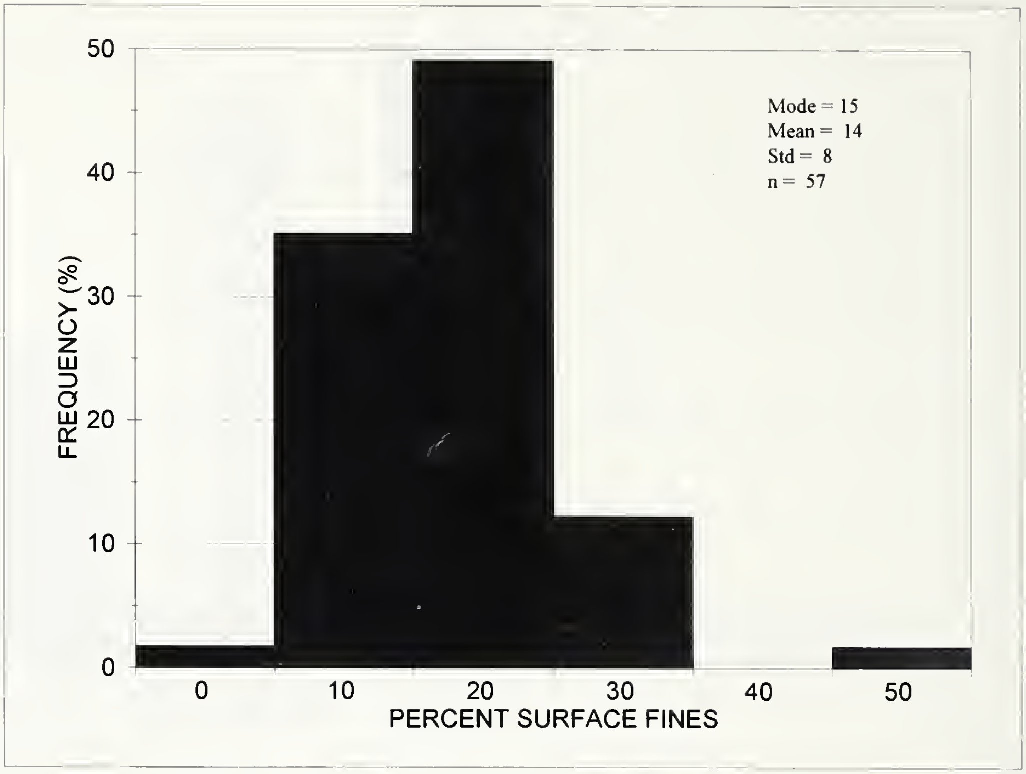

Figure 130—Frequency distribution displaying the range of percent surface fines for "A" channel metamorphic stream reaches.

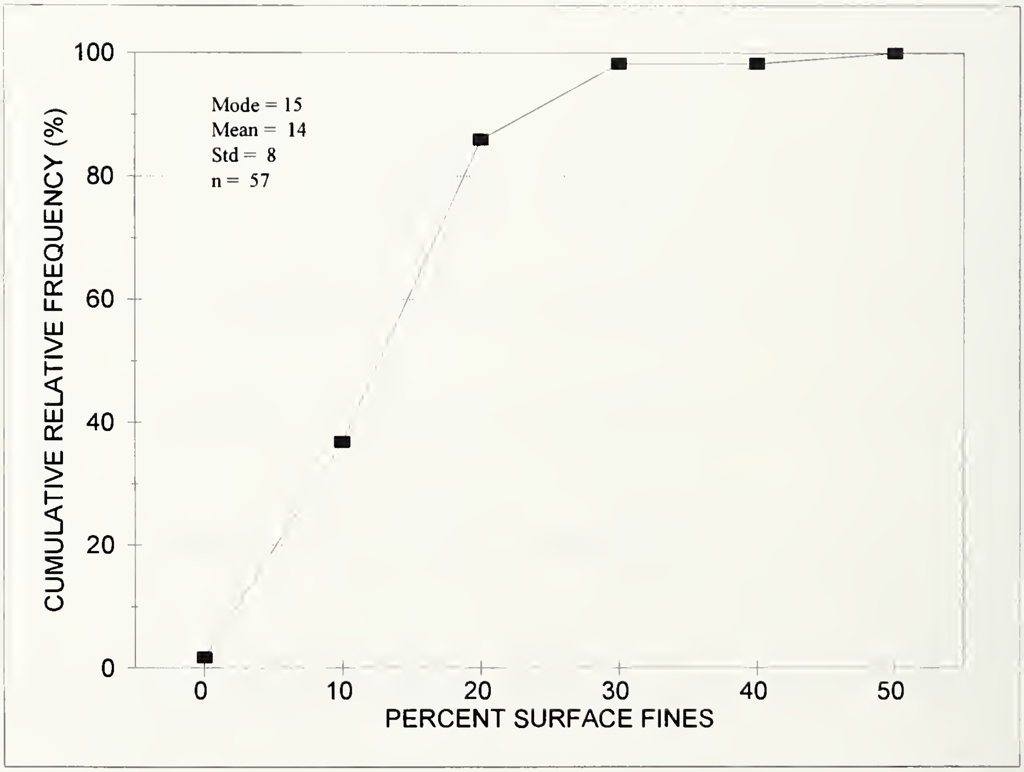

Figure 131—Cumulative relative frequency distribution displaying the range of percent surface fines for "A" channel metamorphic stream reaches.

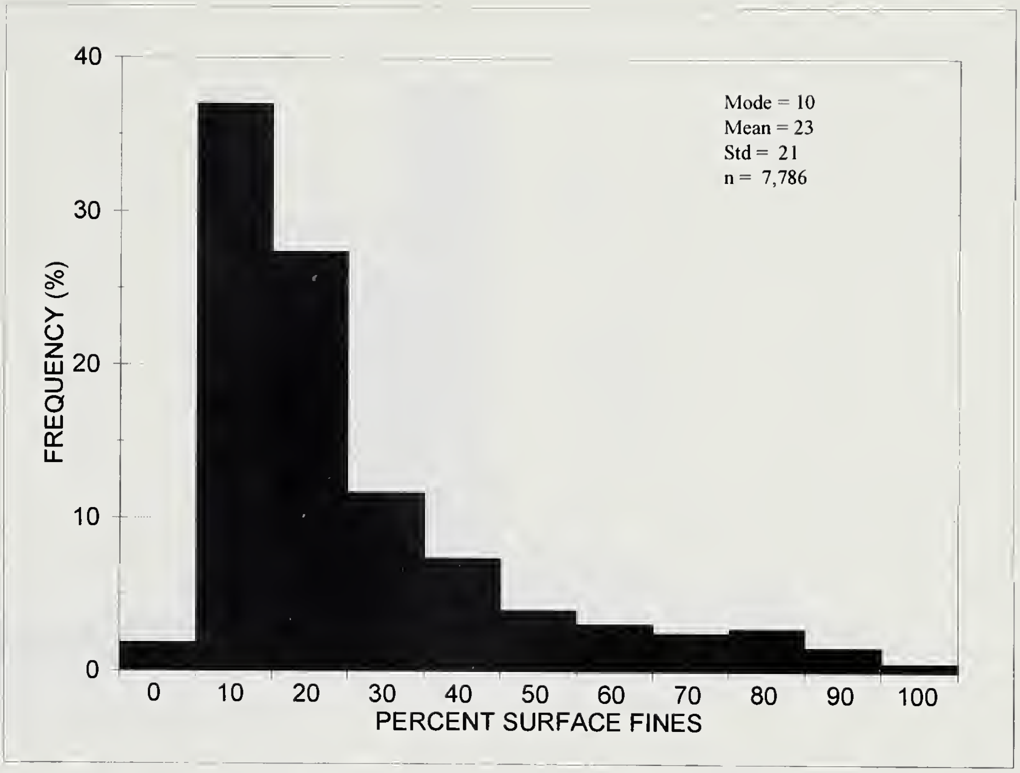

Figure 132—Frequency distribution displaying the range of percent surface fines for "B" channel reach types.

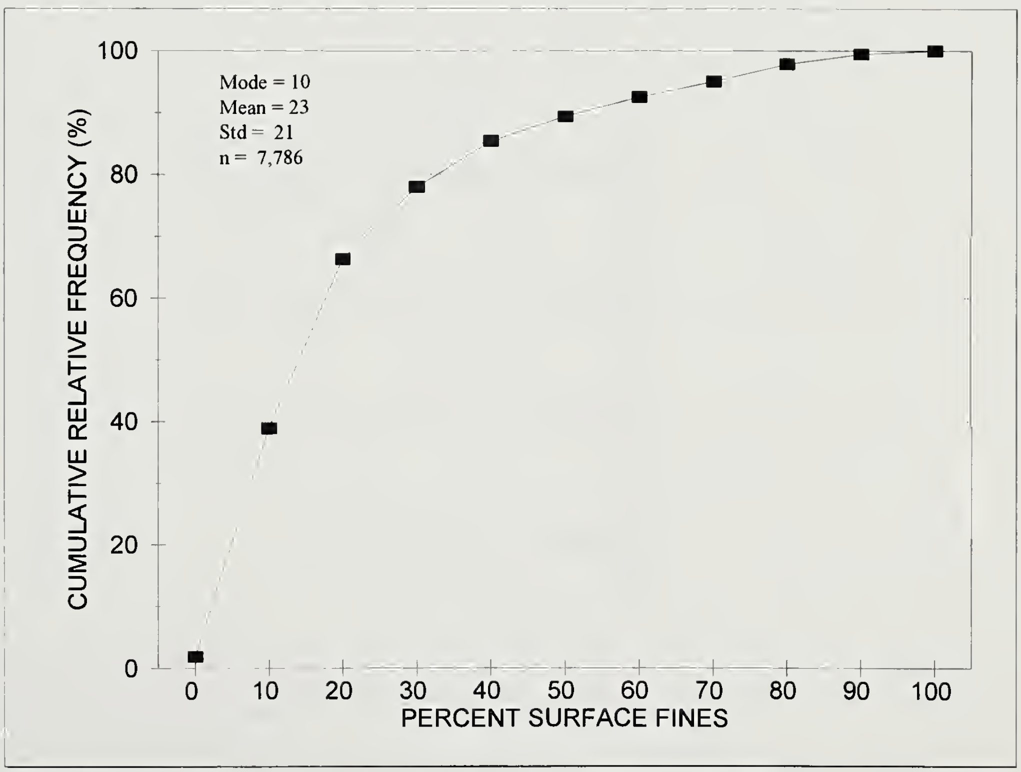

Figure 133—Cumulative relative frequency distribution displaying the range of percent surface fines for "B" channel reach types.

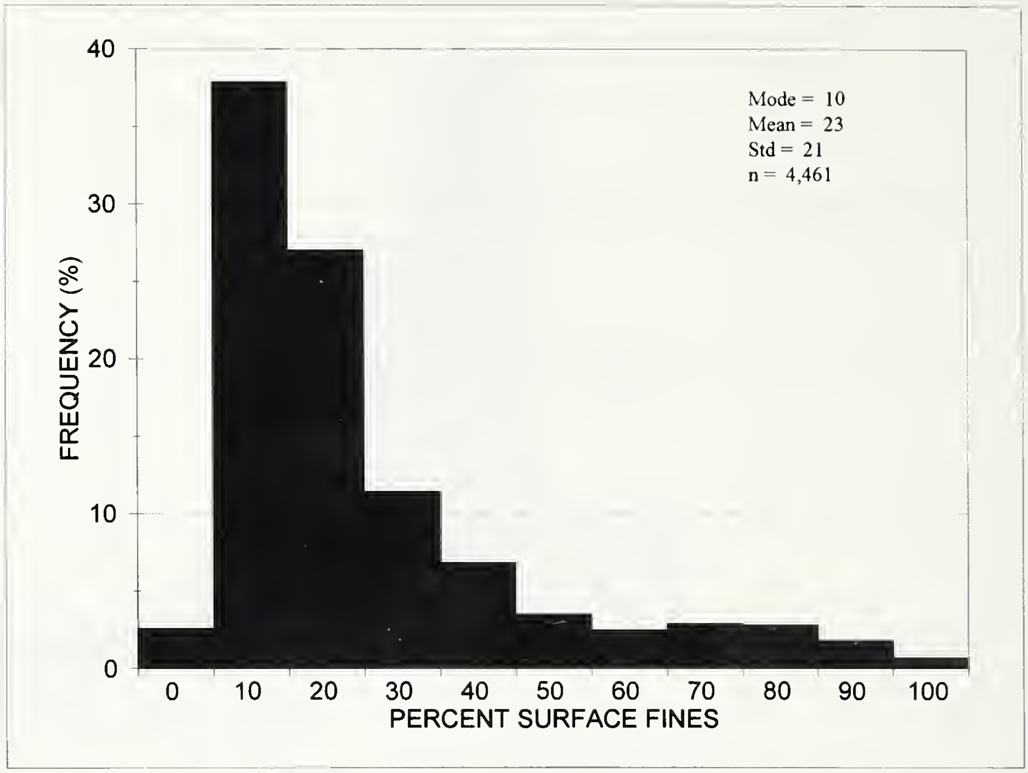

Figure 134—Frequency distribution displaying the range of percent surface fines for "B" channel plutonic stream reaches.

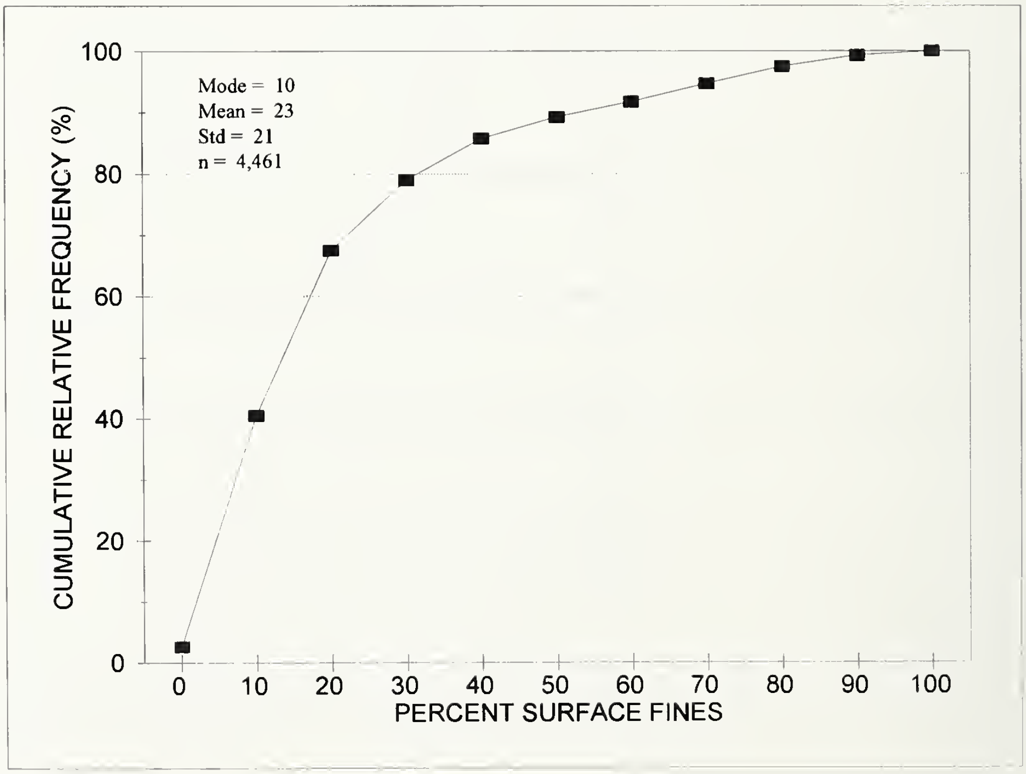

Figure 135—Cumulative relative frequency distribution displaying the range of percent surface fines for "B" channel plutonic stream reaches.

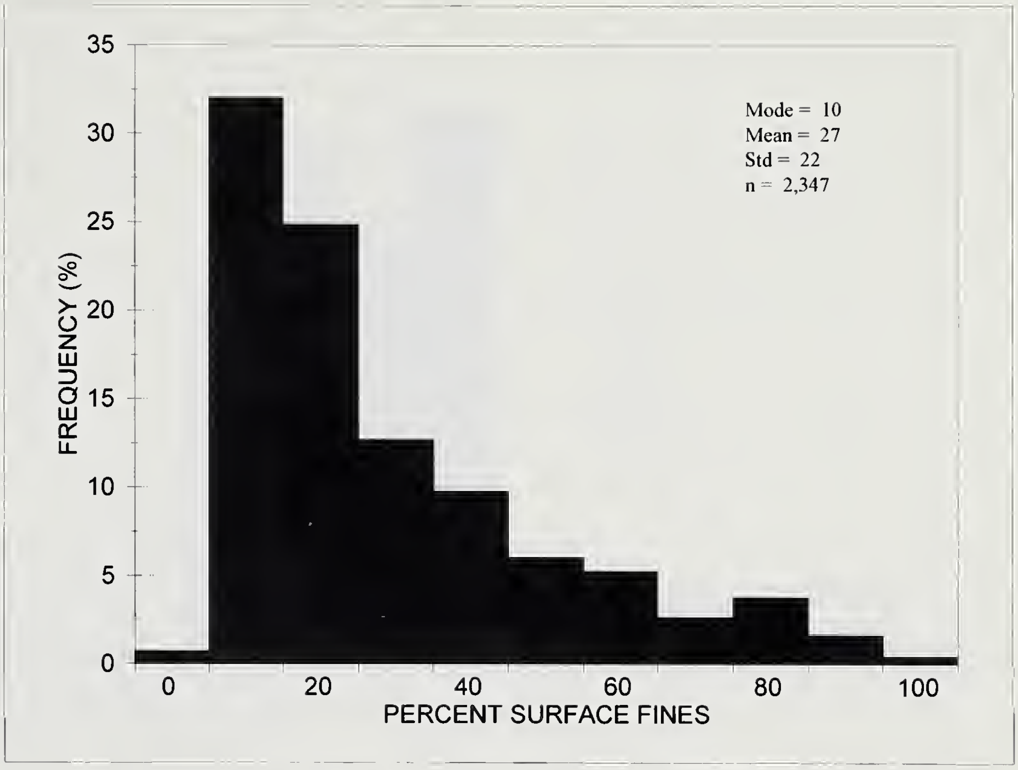

Figure 136—Frequency distribution displaying the range of percent surface fines for "B" channel volcanic stream reaches.

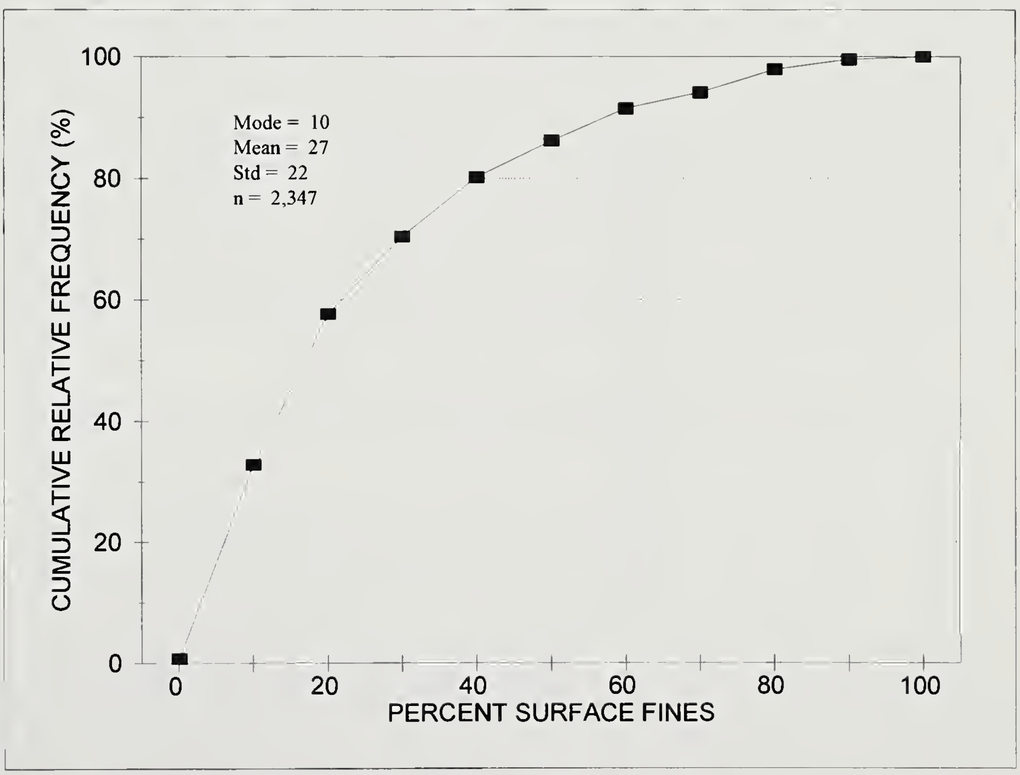

Figure 137—Cumulative relative frequency distribution displaying the range of percent surface fines for "B" channel volcanic stream reaches.

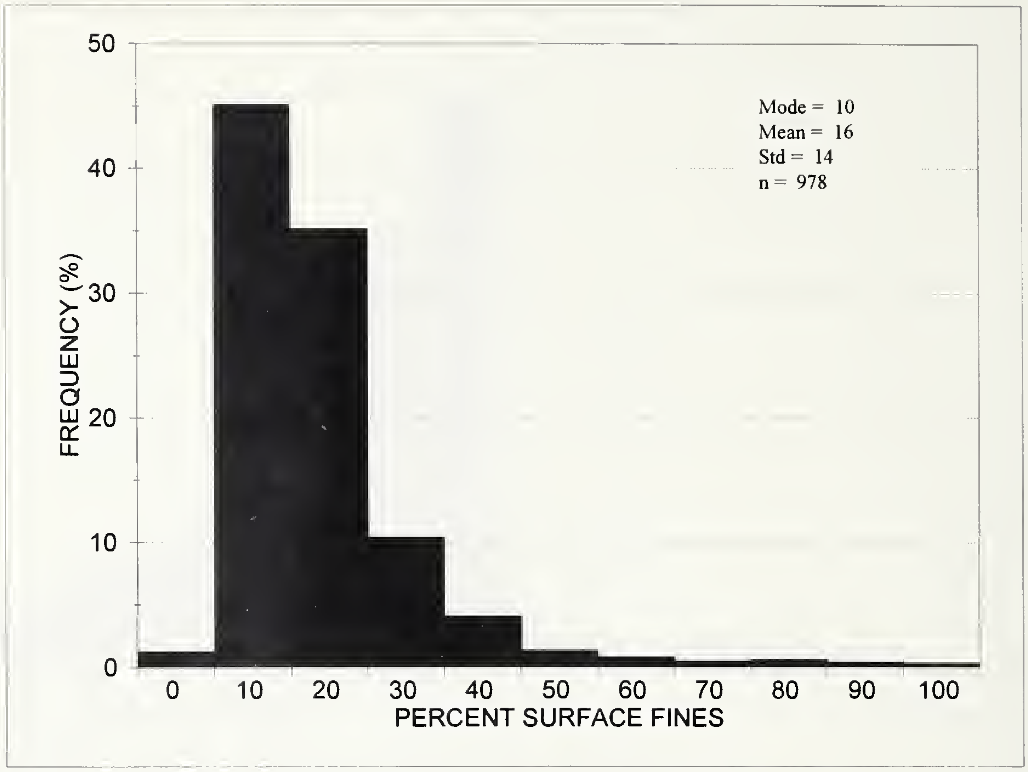

Figure 138—Frequency distribution displaying the range of percent surface fines for "B" channel metamorphic stream reaches.

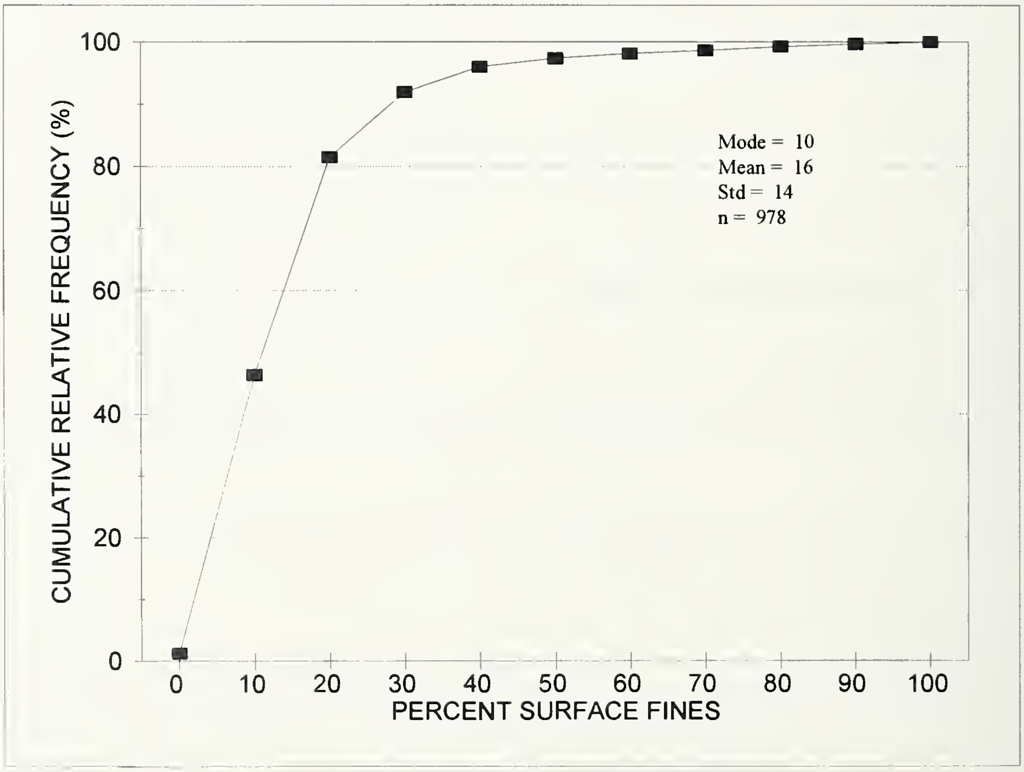

Figure 139—Cumulative relative frequency distribution displaying the range of percent surface fines for "B" channel metamorphic stream reaches.

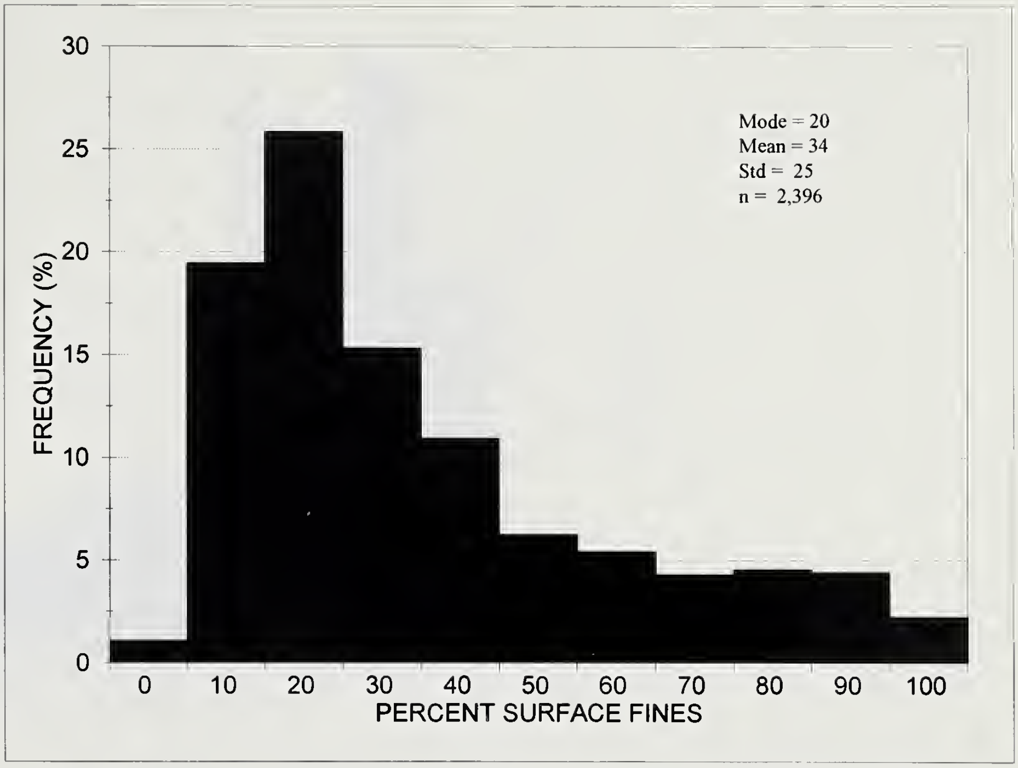

Figure 140—Frequency distribution displaying the range of percent surface fines for "C" channel reach types.

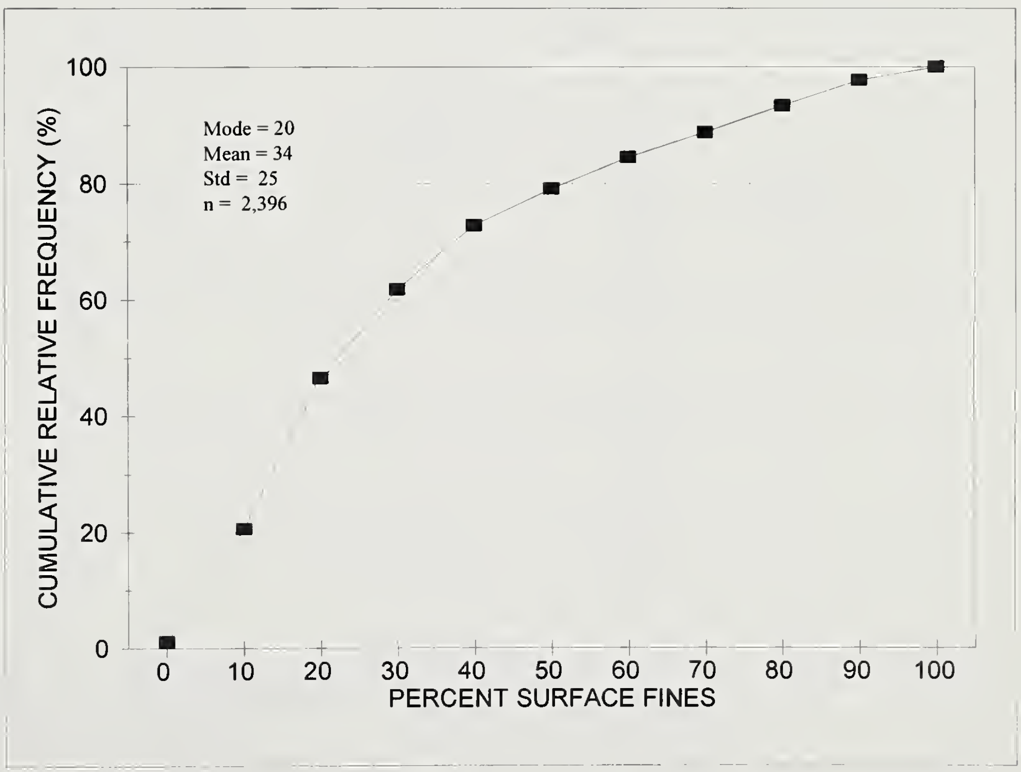

Figure 141—Cumulative relative frequency distribution displaying the range of percent surface fines for "C" channel reach types.

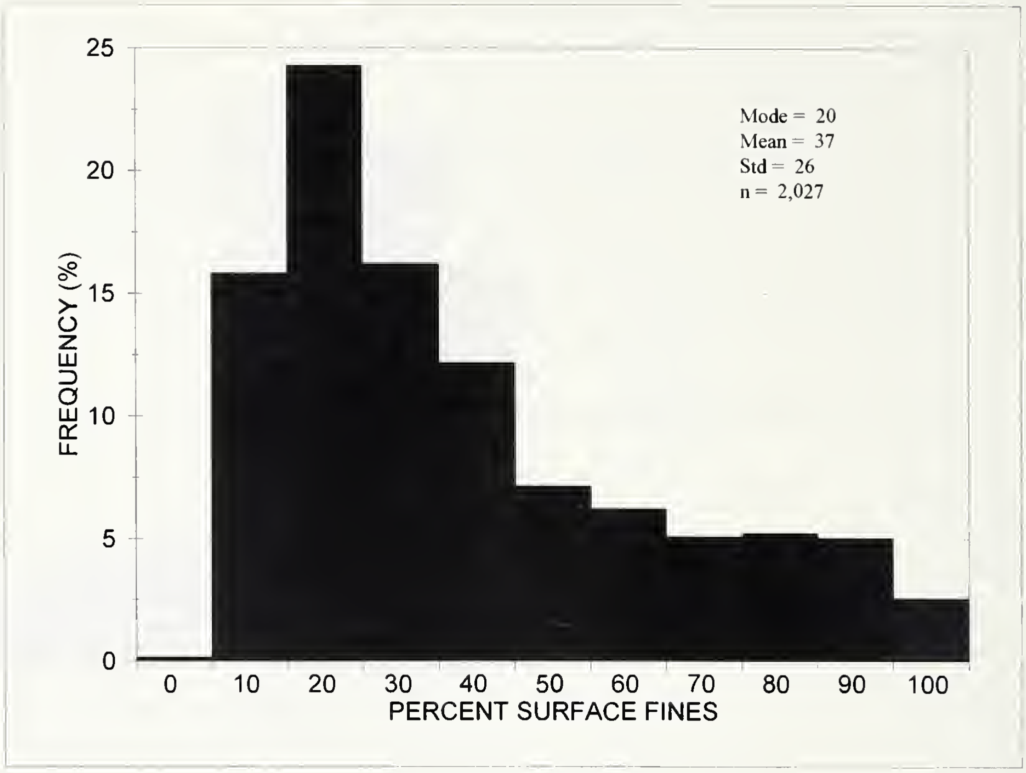

Figure 142—Frequency distribution displaying the range of percent surface fines for "C" channel plutonic stream reaches.

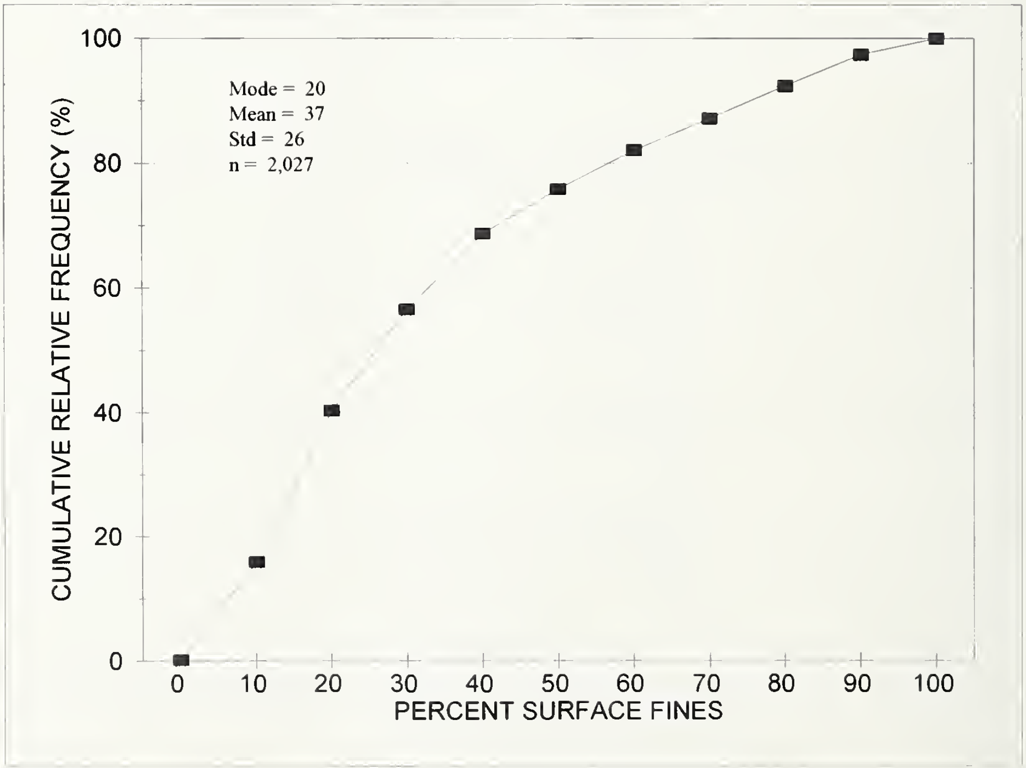

Figure 143—Cumulative relative frequency distribution displaying the range of percent surface fines for "C" channel plutonic stream reaches.

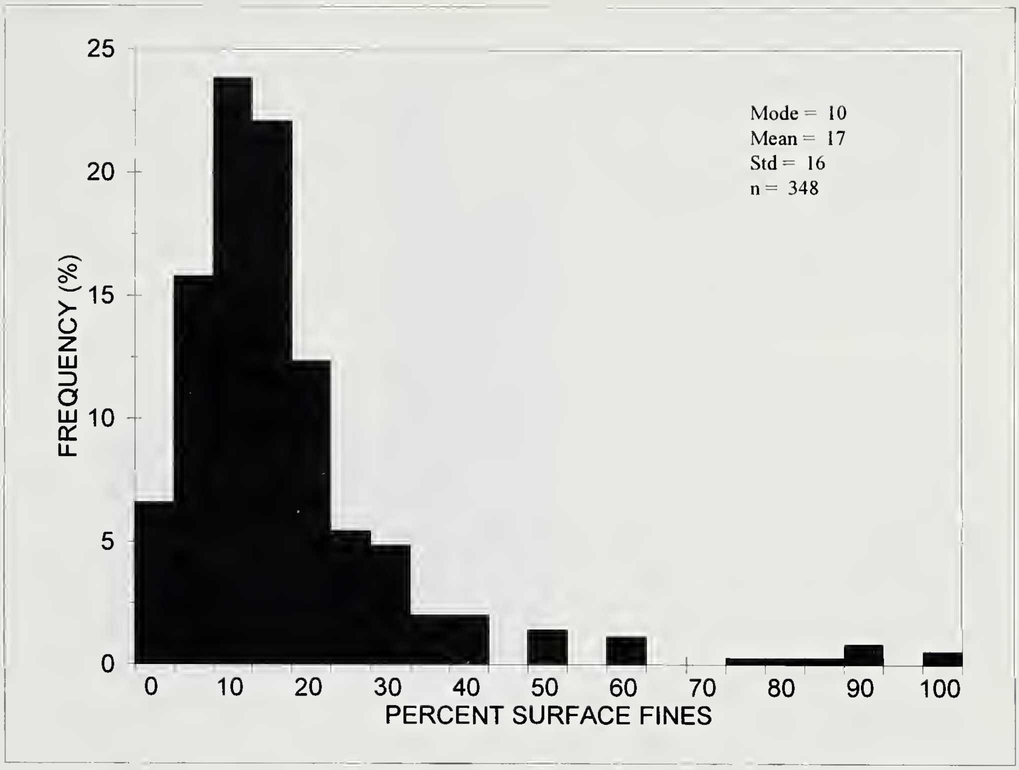

Figure 144—Frequency distribution displaying the range of percent surface fines for "C" channel volcanic stream reaches.

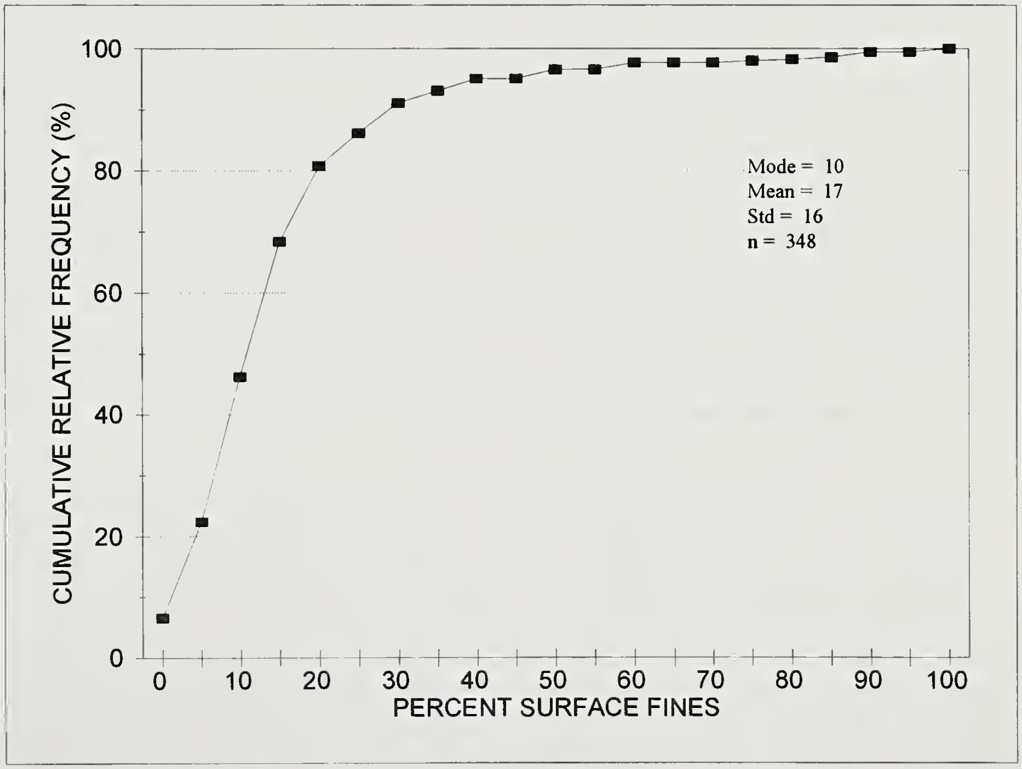

Figure 145—Cumulative relative frequency distribution displaying the range of percent surface fines for "C" channel volcanic stream reaches.

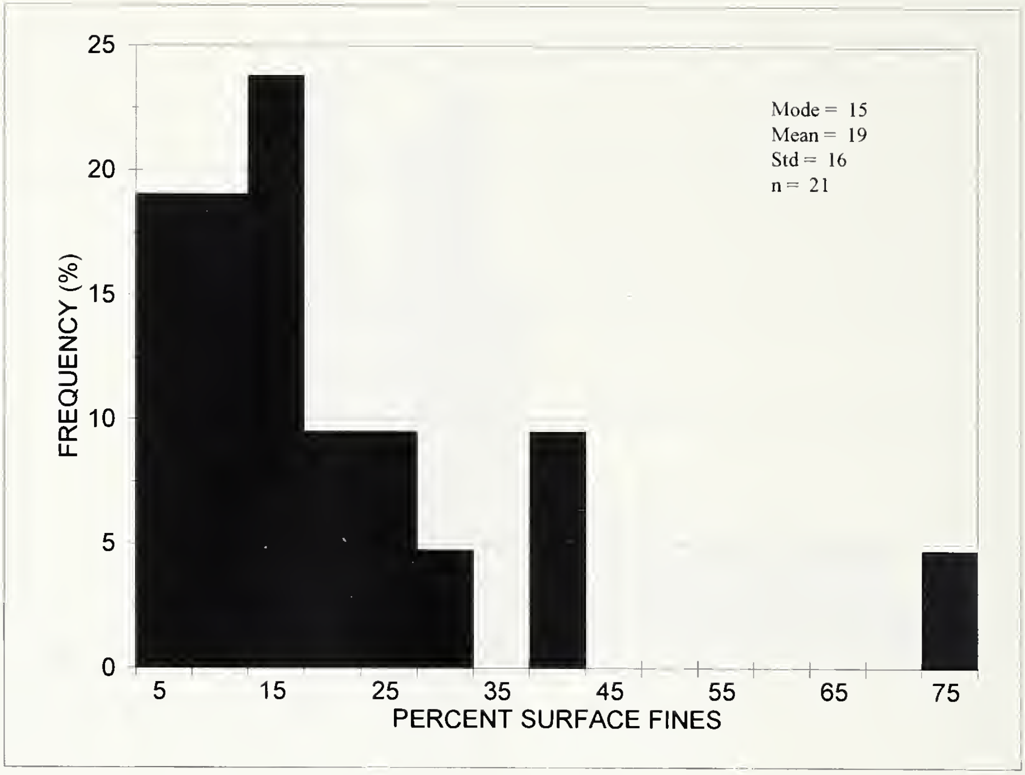

Figure 146—Frequency distribution displaying the range of percent surface fines for "C" channel sedimentary stream reaches.

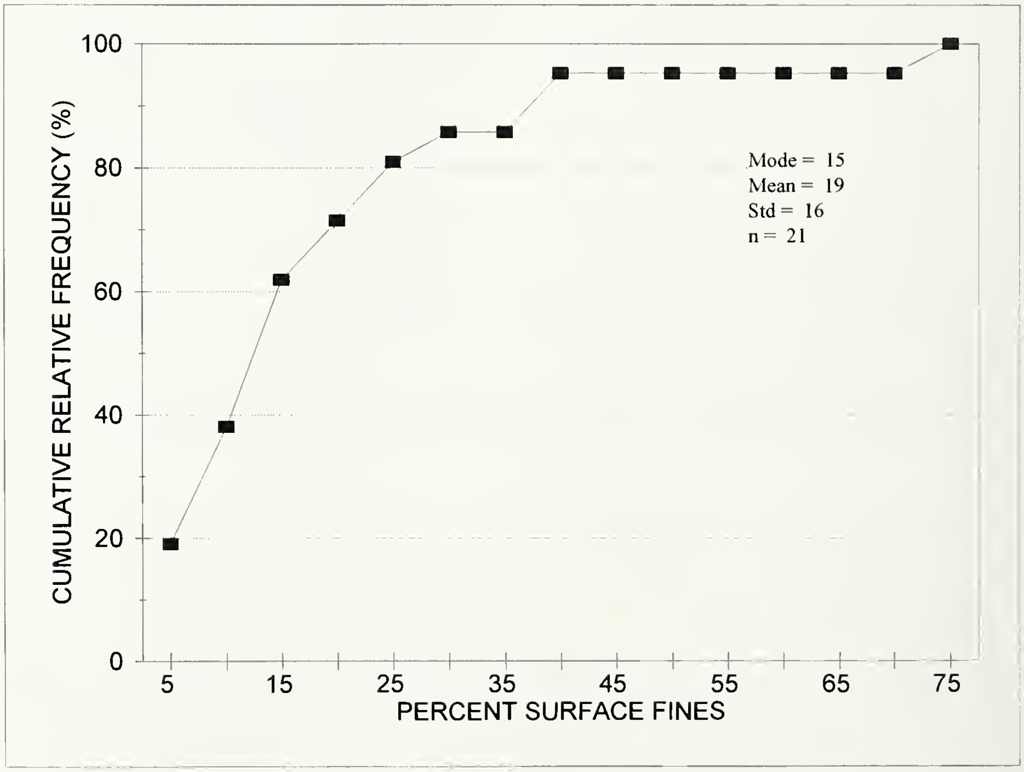

Figure 147—Cumulative relative frequency distribution displaying the range of percent surface fines for "C" channel sedimentary stream reaches.

Large Woody Debris

Large woody debris in forested streams is one of the most important contributors of habitat and cover for fish populations (MacDonald and others 1991; Meehan 1991). Smaller streams usually contain more wood than larger streams (Bilby and Ward 1989; Swanson and others 1982). Bilby and Wasserman (1989) found that streams with finer substrates had about half the large woody debris of streams with boulder or bedrock substrates, and that riparian tree density is positively related to the amount of inchannel large woody debris in eastern Washington streams. Large woody debris volume and location are affected by landslides, windthrow, and floods (Bisson and others 1987; Keller and Swanson 1979). Larger sizes of wood remain in larger channels, while smaller pieces are flushed out.

Large wood is a major component of channel form in smaller streams (Sullivan and others 1987). Large woody debris can influence channel meandering, bank stability, variability in channel width, and the forms and stability of gravel bars (Lisle 1986). It is often responsible for the formation of pools in small streams; Bilby (1984) reported that 80 percent of the pools in small southwestern Washington streams were formed by wood, and Rainville and others (1985) found similar associations in small streams in northern Idaho. The user needs to be cautious when applying wood counts because a high range of natural variability exists and sampling error appears to be high.

All large woody debris that is within the bankfull channel is counted, estimated, or measured for all main channel and side channel habitat types. Pieces of large woody debris spanning the stream that are within the bankfull channel or 1 m above the water are counted. Large woody debris is broken down into three categories:

1. Single piece—must be 3 m in length or two-thirds the wetted stream width (whichever is smaller) and 0.1 m in diameter one-third of the way up from the base. Smaller pieces are easily flushed through the system, and are not retained.
2. Aggregate—a group of two or more pieces, each of which qualifies as a single piece. The total number of all pieces is estimated.
3. Root wads—attached to logs less than 3 m in length. Total length is estimated from the root wad base to the tip of the attached log.

The tabulated statistical summaries report total large woody debris per 100 m (total large woody debris/100 m equals the number of each category added together). Aggregates are counted as one piece because estimated numbers of pieces within an aggregate cannot be accurately determined. Large woody debris counts by linear length are summarized by wetted width classes (tables 8 and 9) because of the influence of stream size.

Pool Frequency

Pools provide important habitat throughout all salmonid life stages (Meehan 1991). The frequency and size of pools is dependent on stream size, gradient, confinement, flow, sediment load, and large woody debris. Human activities on a watershed or local scale that alter any of the above can affect the frequency and size of pools. Table 11 displays the changes in pool frequency between human-disturbed stream channels and wilderness (minimal human-disturbance) streams (Sedell and Everest 1990). We found fewer deep pools in an intensely timber-managed watershed when reaches with similar drainage areas were compared to a nontimber-managed watershed (Overton and others 1993).

Table 11—Changes in large pool habitats (≥ 2.5 ft deep and ≥ 25 yd^2) in selected subbasins of the Columbia River Basin over the last 50 years (Sedell and Everest 1990).

Location	Large pools/mile		
	1941	1990	Change
			Percent
Middle Fork Salmon River, ID			
Marsh Creek	20.0	21.0	5
Rapid River (wilderness)	5.8	5.2	–10
Elk Creek	56.1	32.9	–41
Grande Ronde River, OR			
Grande Ronde River (ms)	6.1	2.0	–67
Catherine Creek	17.7	4.4	–75
N. Fk. Catherine Creek	8.6	3.1	–65
S. Fk. Catherine Creek	17.6	2.4	–86
Five Points Creek	2.5	2.5	NC
Beaver Creek	17.4	2.6	–85
Meadow Creek	3.9	3.0	–26
McCoy Creek	16.4	2.5	–85
Sheep Creek	23.8	11.3	–53
Willamette River, OR			
N. Fk. Breitenbush R. (managed)	19.0	6.6	–65
N. Fk. Breitenbush R. (wilderness)	3.0	20.0	666
Horse Creek	12.0	7.5	–37
S. Fk. Winberry Creek	14.0	7.6	–46
Fall Creek	16.6	6.5	–61
S. Fk. McKenzie River	25.4	4.5	–82
Lewis and Clark River, OR			
Lewis and Clark River	17.4	7.0	–60
Yakima River, WA			
Little Naches River	4.2	5.3	29
Taneum River	2.0	2.6	30

Pools are easily identified by visual characteristics because of their dished-out morphological shape and flow patterns. Pools can be further broken down based on pool type (scour versus dammed), position of scour (mid versus lateral), and formative feature (large woody debris, bedrock, and so forth). Channel reach class, stream size, and riparian vegetation govern the types of pools. For example, lateral scour pools are formed by meanders in response reaches; the morphology is influenced by discharge, sediment transport and disposition, bank stability, and riparian vegetation.

Pool length, width, mean depth, tail crest depth, and maximum-depth are measured or estimated. Only main channel pools, excluding pocket pools and side channel pools, are used to determine pool frequency. Step pool complexes are counted as one pool. Thus, reaches with step pool complexes should not be compared unless the total number of pools within the complex are known.

A field inventory of pools is conducted at summer base flows in an attempt to maintain consistency of measurements. Changes in flow will affect all pool measurements except residual depth (Lisle 1987). Pool frequency is reported by wetted-width classes because of the influence stream size has on pool spacing (tables 8 and 9).

Other Natural Condition Descriptors

Besides the habitat type attributes listed above, other descriptors collected during the field survey (table 3) may be useful for describing natural conditions of stream channel and fish habitat. Statistical summaries can be calculated for all stream channel attributes (table 3) that are field sampled using the

R1/R4 Fish and Fish Habitat Standard Inventory Procedures. These summaries can be completed by using dBaseIV queries, or transferring data to other relational data bases, statistical programs, or spreadsheet software. We have developed a link between the Geographic Information Systems (ARC Info) and the inventory data base, permitting spatial display of any of the habitat variables.

Further research on the relation between watershed disturbances (natural or human), physical and biological processes, and physical and biological responses will create better data for more refined determinations of current and potential habitat conditions for an analysis area.

General Assumptions and Limitations

The user needs to keep in mind that these stream channel attributes must not be used as management goals in and of themselves. The wide range of natural variation of individual stream habitat variables and the complex and little-understood interplay between them (such as numbers of pools and pieces of large wood, percent fine sediment, and water temperature) make it difficult to establish relevant quantitative management directives for habitat features (FEMAT 1993).

The following assumptions and limitations should be considered in any analysis that compares managed streams to natural condition reference streams listed in this document.

1. The numeric ranges described here were assumed to represent natural or potential habitat conditions that meet the life stage requirements of salmonids in Idaho.
2. We assumed that land management is likely to reduce pool frequency and pool depth and volume, cause fewer and smaller large woody debris, increase surface fines, reduce bank stability, and increase widths.
3. High variation between and within streams exists because of the changing climate, geology, vegetation, and adjacent land-use practices along stream systems.
4. Natural successional stages in vegetation affect instream characteristics. The frequency of change was historically related primarily to fire frequency and sequences of events varying from 1- to 10-year intervals, to intervals of hundreds of years.
5. These numeric values or ranges will not be representative of all channel types (such as boggy meadow streams). When using variables to assess the conditions of project streams, the user should select numeric values from stream reaches that are most similar in geology, vegetation, geomorphology, and climate.

Suggested Reading

Meehan, W. R. 1991. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19. Bethesda, MD: American Fisheries Society. 751 p.

This is the most updated assemblage of information and references on the interrelations between salmonid production and the management of forest and range lands. This invaluable reference describes stream ecosystems and how they relate to salmonid habitats, life histories and distributions of salmonids throughout North America, and responses of fish populations to the changes brought about by land management activities.

Easterbrook, D. J. 1993. Surface processes and landforms. New York: MacMillan Publishing Company. 520 p.

This recent publication in geomorphology describes surface processes and landforms and provides information and references on the evaluation of landforms and interpretation of their origin. There is an increasing relevance of geomorphology to environmental concerns, placing emphasis on the applied aspects of geomorphology.

Arnold, J. F. 1975. Descriptors of sections and subsections of that portion of the Northern Rocky Mountain Physiographic Province containing the Idaho Batholith. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Region. 342 p.

This is a comprehensive description of physiography, structure, lithology, vegetation, soils, elevation, and climate of the Idaho Batholith Province lands.

Rahm, G. N.; Larson, K. 1972. Land characteristics and soil and hydrologic evaluation for the Sawtooth, White Cloud, Boulder, and Pioneer mountains. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Region. 135 p.

This document on the soil and hydrologic phase of the study area contains general descriptions of climate, physiography and geomorphology, geology, soils, and land group and type characteristics. It also contains an evaluation of uses and activities with hazard class rating.

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Appendix A: Photographs of Idaho's Salmon River Basin Anadromous Fish-Bearing Streams

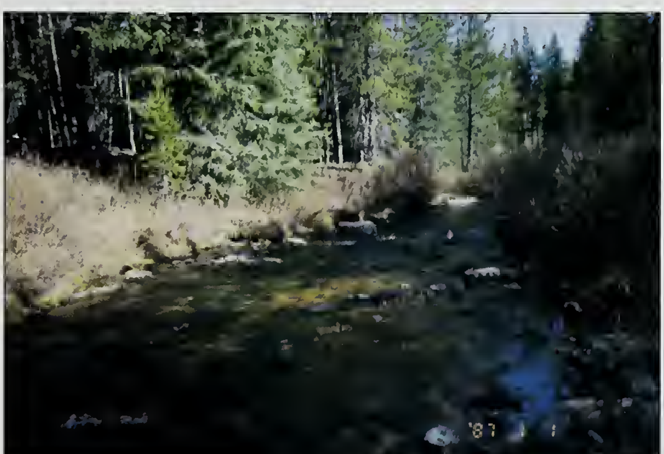
These photographs for many of the inventoried stream reaches represent the natural condition data base. The reader can use the photos when comparing the features of stream channel cross sections not influenced by major human disturbance to photographs from disturbed stream reaches. Photographs are identified with the index number that coincides with the index number in tables 4, 6, and 7 to link the photograph to stream name and general stream characteristics. Often times more than one photograph appears per stream. The reach number appears below each photo.

Index 1—Alpine Creek

1

1

Index 2—Banner Creek



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1

Index 3—Basin Creek

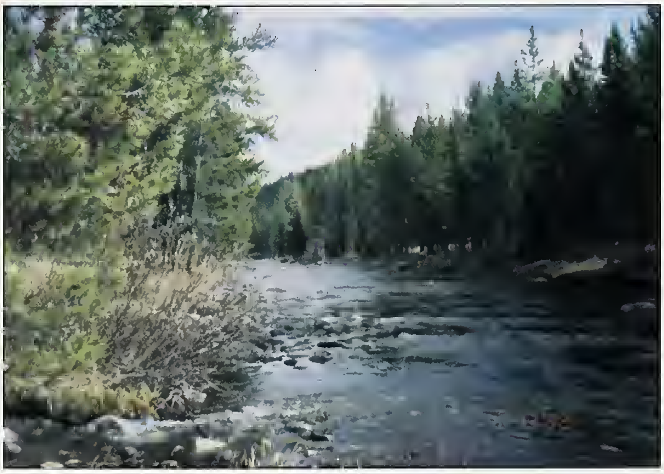
9

9

9

10

Index 4—Beaver Creek



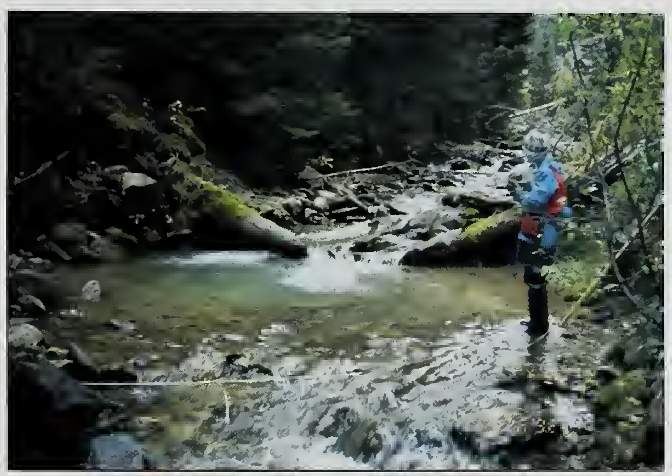
2

Index 6—Big Chief Creek

1

1

Index 7—Big Cottonwood Creek



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Index 8—Browning Creek

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Index 10—Capehorn Creek

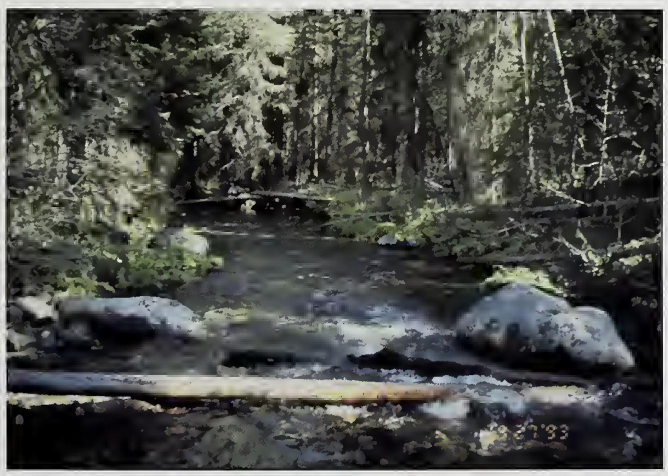
3

Index 11—Caton Creek

1

3

Index 12—Chamberlain Creek



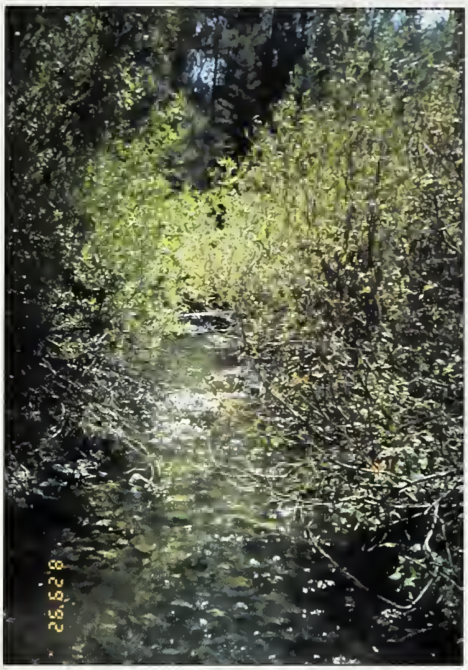
13

Index 14—Chamberlain Creek, West Fork

2

Index 15—Champion Creek

9



9

Index 16—Champion Creek, South Fork

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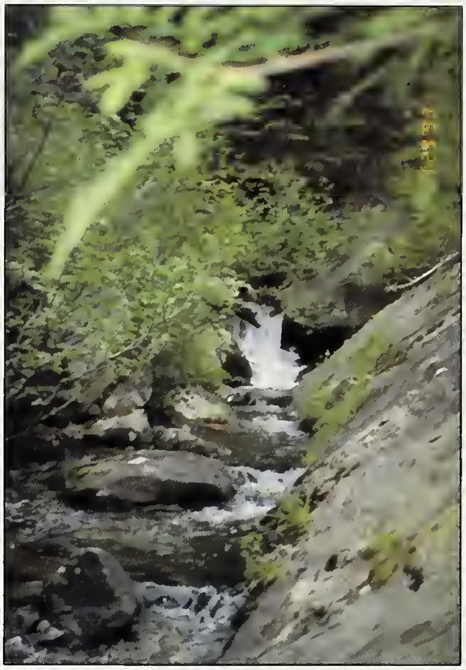
2

Index 18—Cly Creek



3

Index 19—Dynamite Creek

1

1

Index 20—Fishhook Creek

1

1

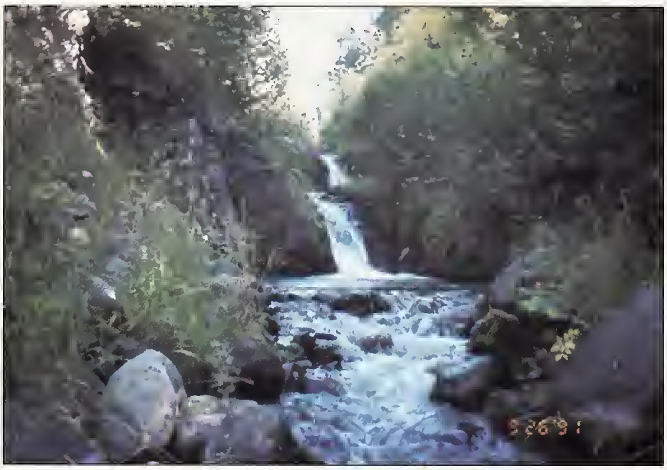
Index 21—Float Creek

1

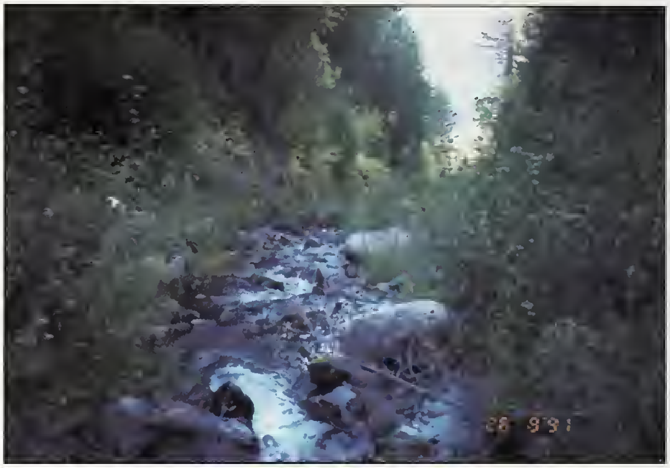
1

1

Index 22—Frypan Creek



1



1

Index 23—Garland Creek

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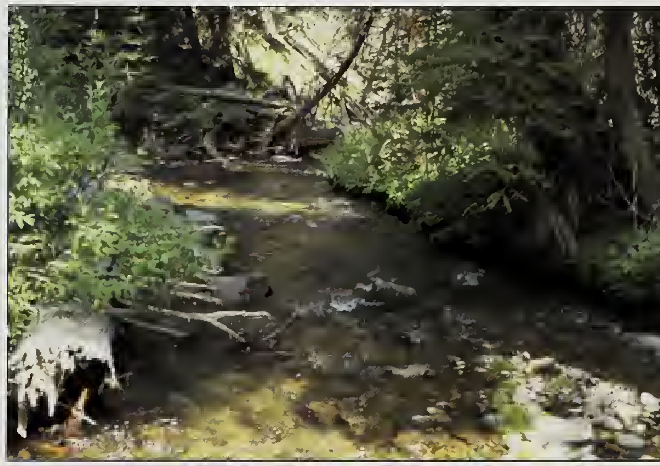

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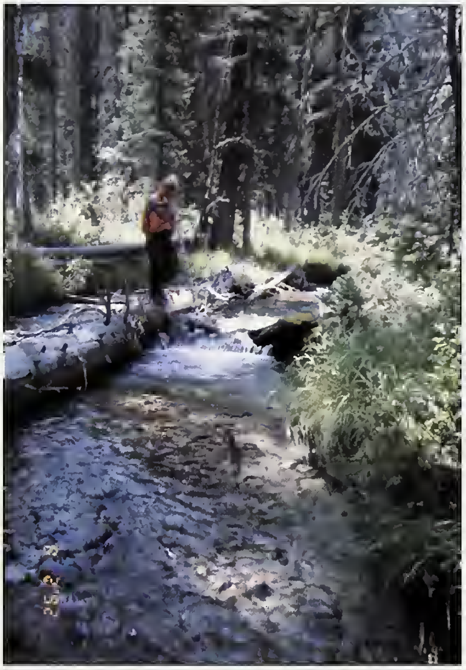

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Index 26—Hayden Creek, East Fork

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Index 27—Hell Roaring Creek

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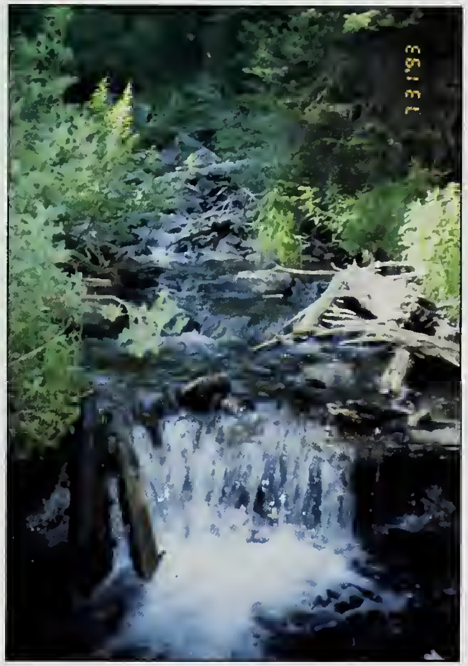
Index 28—Hum Creek



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Index 30—Indian Creek

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Index 30—Indian Creek (Con.)

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Index 31—Knapp Creek

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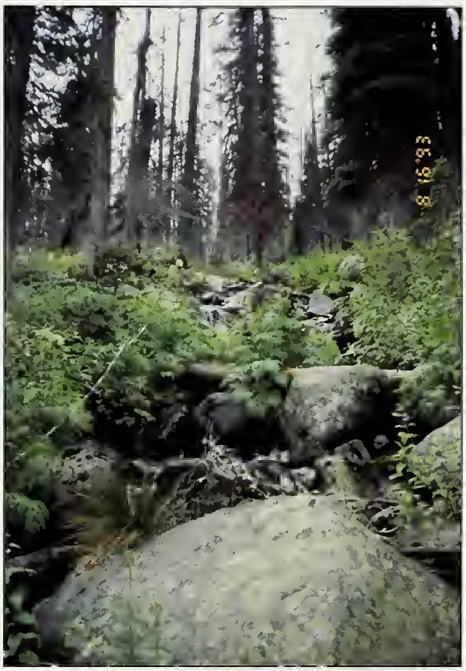
Index 35—Lick Creek, unnamed tributary



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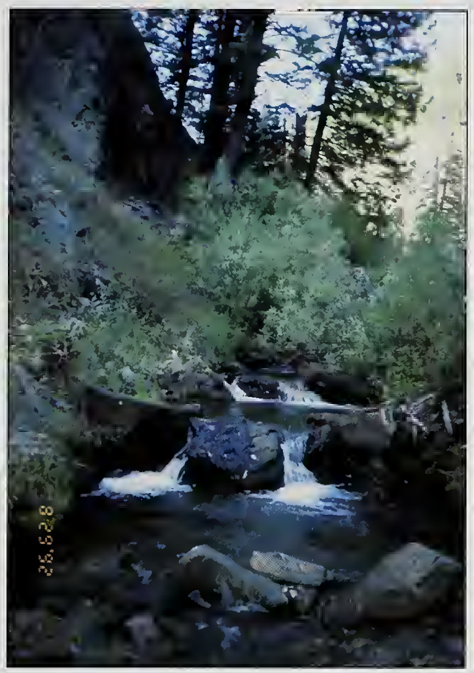

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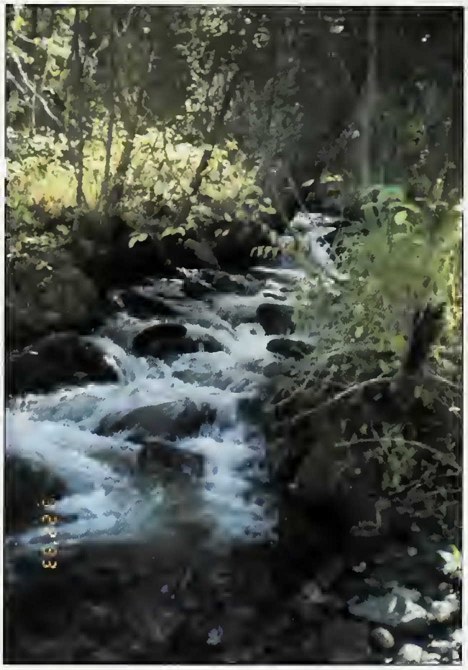

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Index 41—Marble Creek

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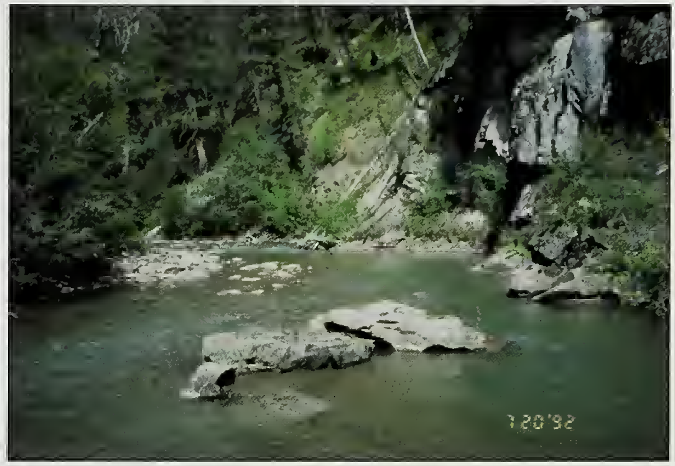

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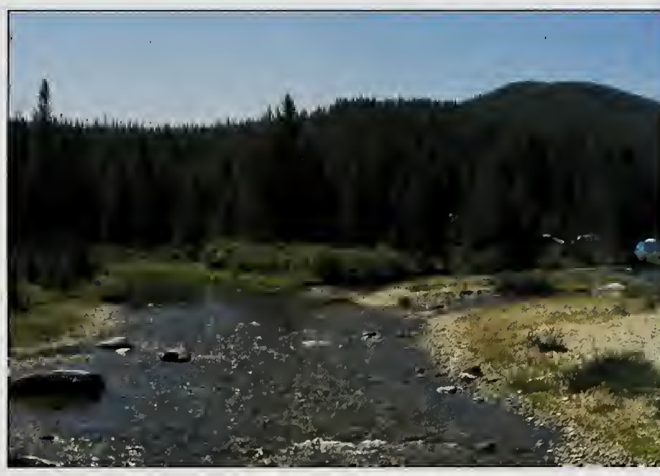

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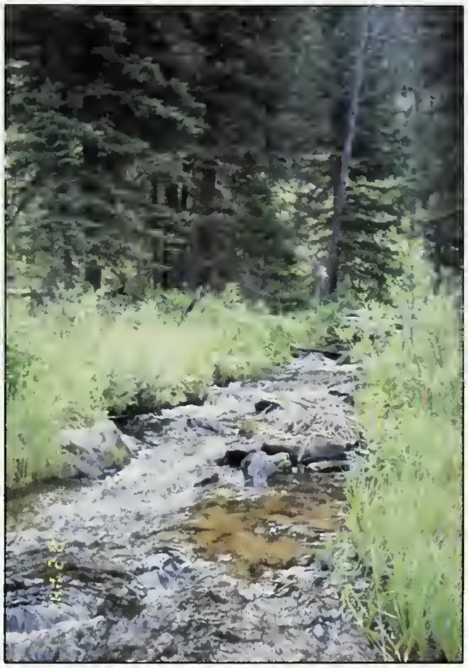

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Index 46—Monumental Creek

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Index 47—Mormon Creek

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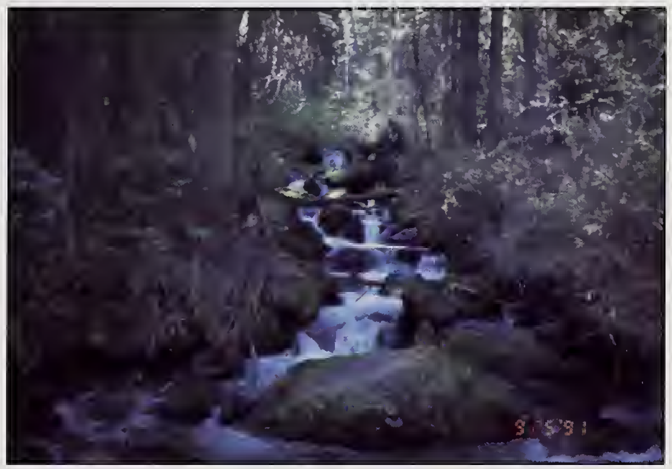
Index 48—Paradise Creek



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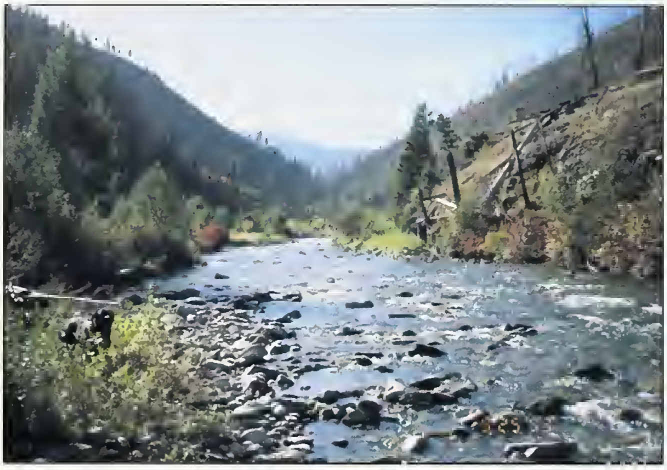

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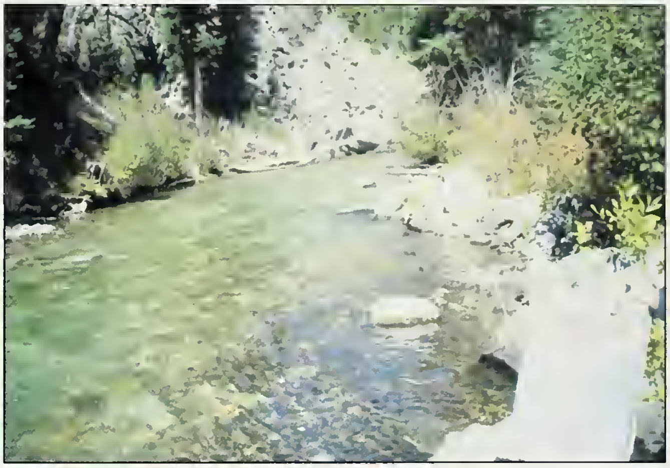

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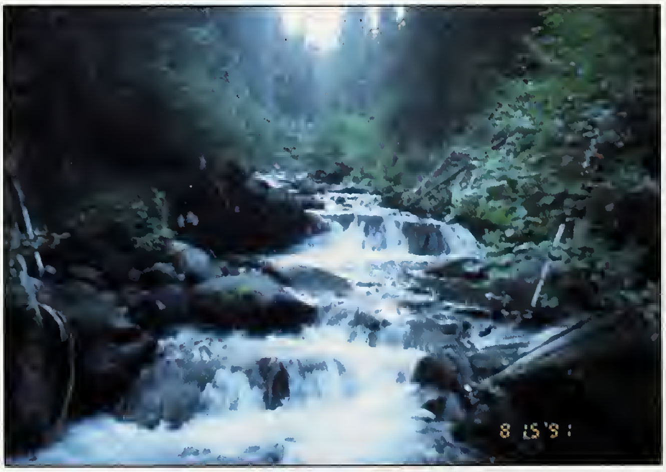

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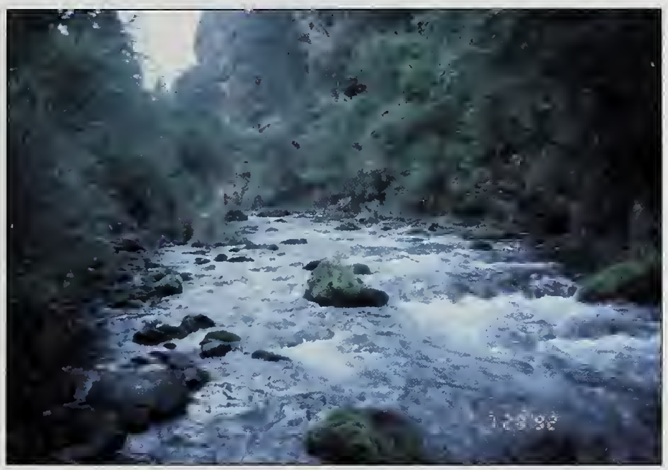

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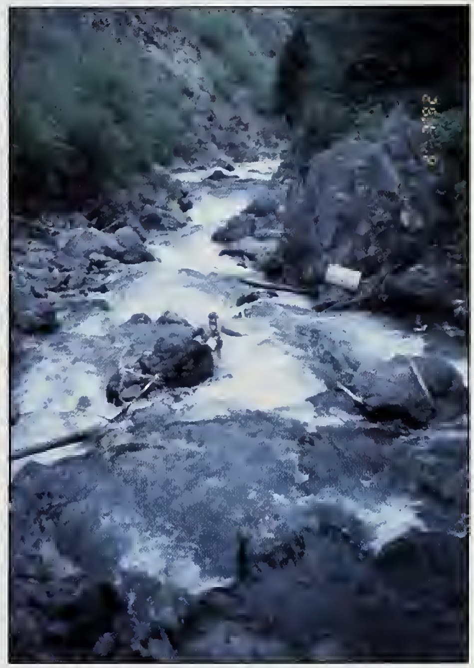

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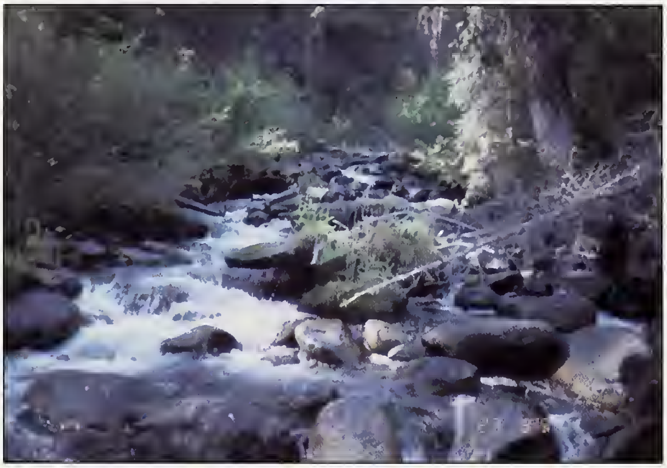

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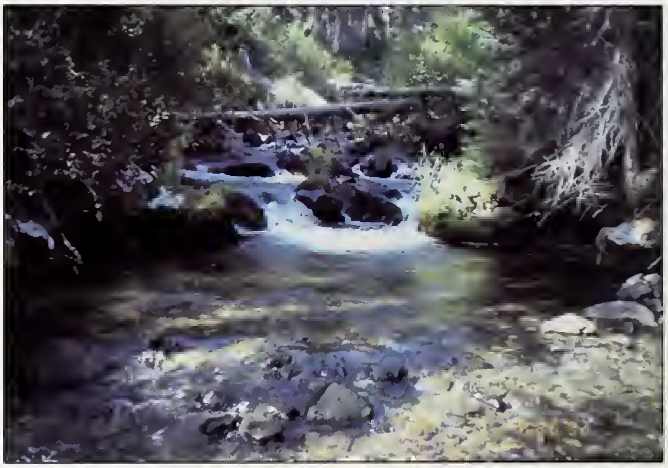

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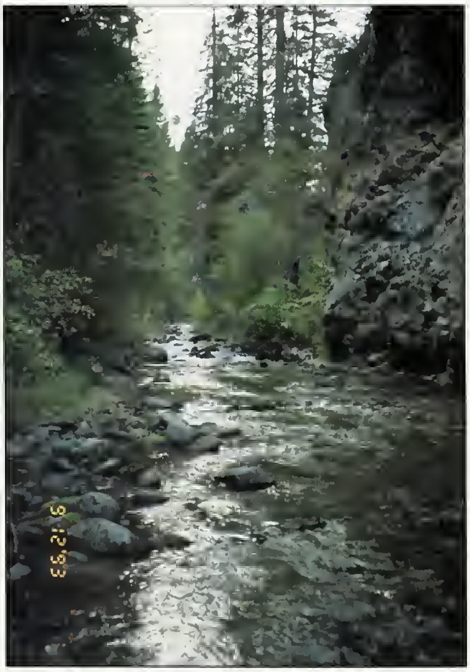

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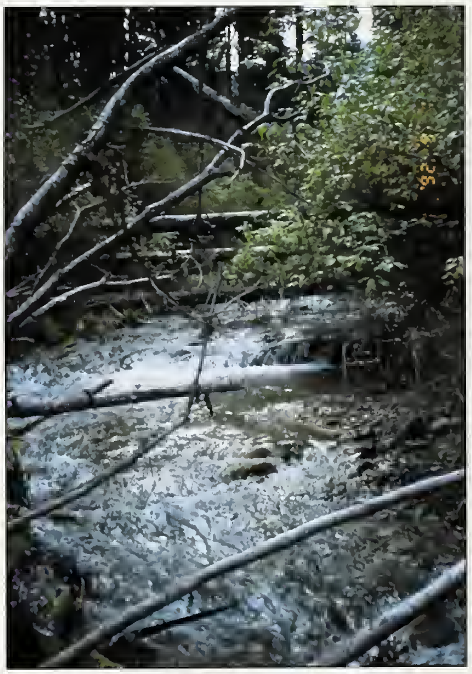

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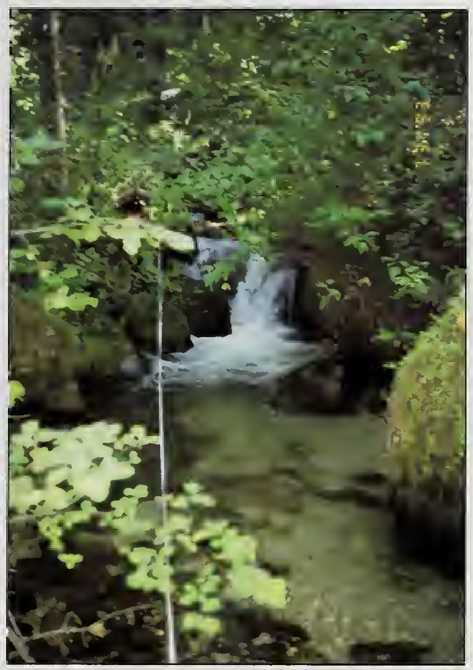

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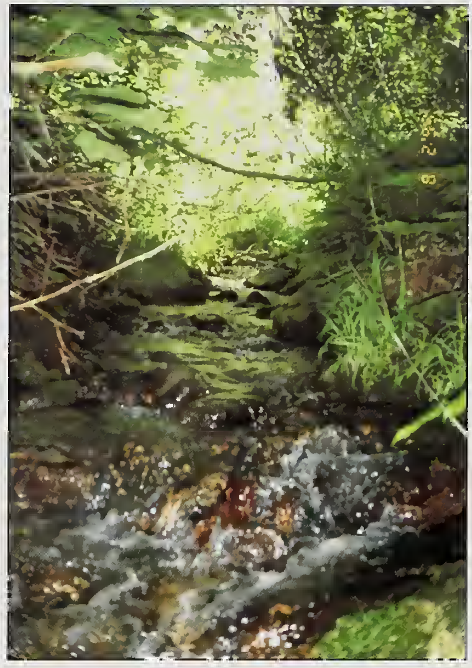

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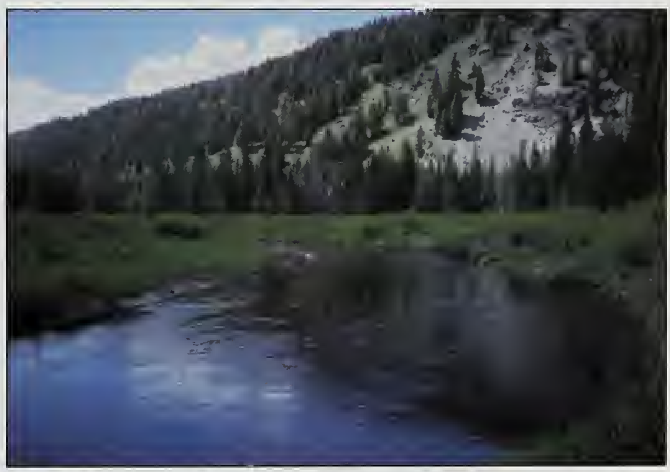

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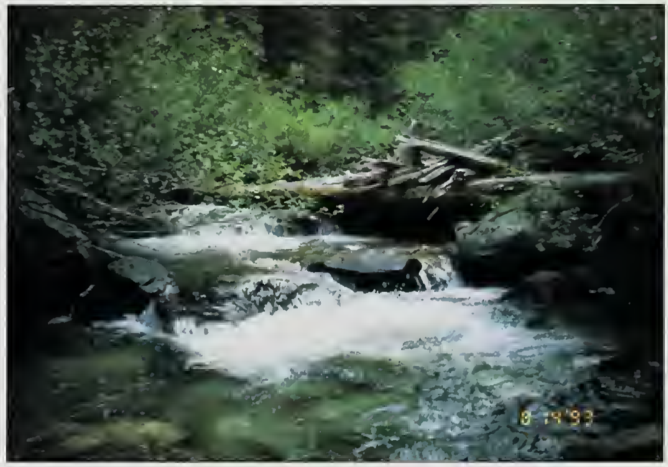

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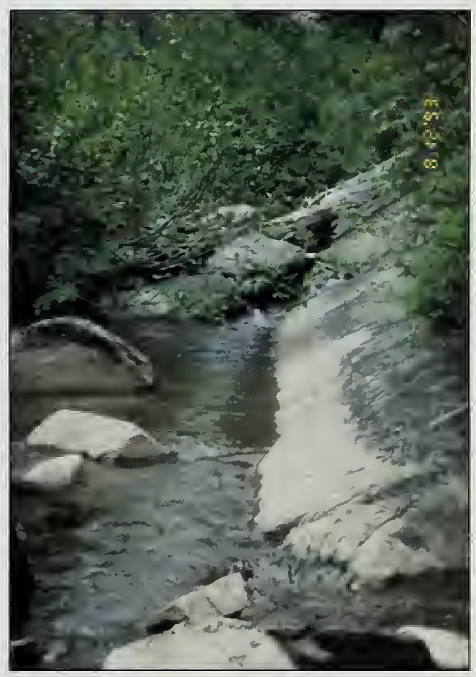

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Index 71—Vanity Creek

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Index 73—Warm Springs Creek

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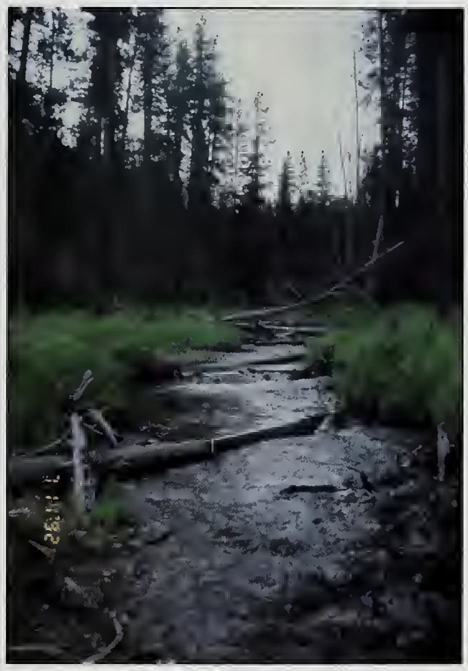
Index 74—Whimstick Creek



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Index 75—Whimstick Creek, East Fork

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Index 76—Whimstick Creek, South Fork

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Index 77—Whimstick Creek, West Fork

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Index 78—Wilson Creek

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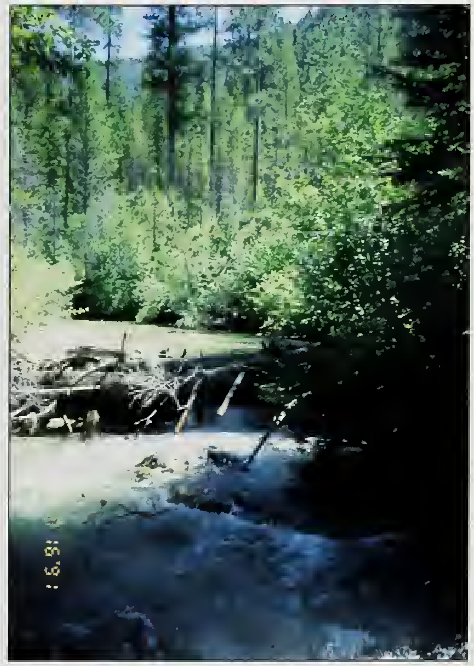

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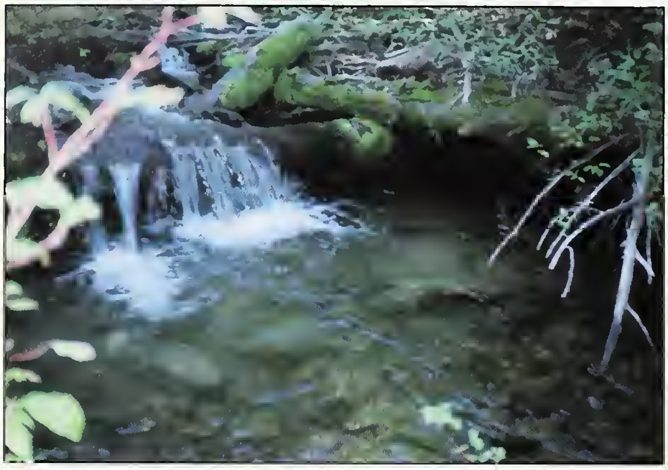

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Appendix B: Salmon River Basin Geology

The Forest Service, U.S. Department of Agriculture, is currently inventorying streams in central Idaho to quantify available anadromous fish habitat. This survey contrasts least disturbed watersheds with managed systems to evaluate habitat differences. To compare streams and their drainages accurately, we need to know important qualifiers such as climate, watershed area, channel gradient, and geologic conditions. Stream morphology, bank stability, soils, water quality (turbidity), sediment load, and surface fines in the stream are influenced by the parent material of the stream bed and watershed. However, even similar geologies can respond differently to factors such as precipitation (acidity).

This appendix explains the Salmon River Basin's physical geology and the logic behind the classified lithology of streams and their watersheds. Because rocks are composed of minerals, we assume the reader knows basic mineralogy. The intent is to provide biologists with information on the basic geologies of 80 streams to assist in making informed management decisions.

The Salmon River drains a large, mostly forested basin in central Idaho. The Salmon River country is characterized by high rugged mountains. Its topography is typical of many dendritic drainages with tributaries forming steep v-shaped canyons (Myers Engineering Co. 1985). Dendritic drainage networks are characteristic of soils with a homogeneous resistance to erosion. Many tributaries have cut steep rock canyons with meadows at the headwater areas. The upper Salmon River flows through the Stanley Basin, its waters originating in the Sawtooth and White Cloud Mountains. The whole Salmon River Basin is an extensive area of forested mountains, sagebrush-covered lower slopes, and deeply incised river canyons (Federal Energy Regulatory Commission 1987).

Dominant geology for the watershed of all inventoried streams was determined with the help of Forest Service District geologists and biologists and by referral to U.S. Geological Survey maps (table 4 in main text). This was difficult due to the nature of finding first- and second-order streams on a 1:250,000 geological map. Spatial scale can be a problem; that is, thinking of and moving between map scale and a 1:1 ground-truthing level. Such different perspectives can mask an overall view of the watershed to determine the

dominant geology. The following geology classification breakdown was used to quantify the underlying material:

Gross:	Plutonic (intrusive)	Volcanic (extrusive)	Metamorphic	Sedimentary
Subclass:	Granitic	Basaltic/Andesitic	Quartzitic	Coarse
	Dioritic	Rhyolitic	Metasediment	Fine

Volcanic and plutonic geologies make up the largest percentage of land mass within the Salmon River Basin, with small intrusions throughout the area. Some streams, such as Champion Creek, flow along a fault separating two geologies. The dominant geology is determined from the stream's entire watershed, not just where the stream flows. Recognizing the problems inherent in any classification system, and how nature does not make it easy, the streams are categorized (table 4 in the main text).

Three major distinct geologies occur in the Salmon River Drainage: (1) the Idaho Batholith of the Cretaceous period, a composite mass of granitic plutons; (2) Challis volcanics of the Eocene epoch, rocks with varying composition; and (3) other geologies, the most important of which is a metamorphic/metasediment portion in the Middle Fork and main Salmon Rivers, also sedimentary formations. Much of the modern topography formed over the last 2 million years during glacial and interglacial periods of the Pleistocene epoch. Each geology will be discussed in detail below with example streams given for illustration. The third metamorphic type is a complex geology beyond the scope of this paper to discuss.

Idaho Batholith

The Idaho Batholith, covering approximately 15,400 square miles, was emplaced 100 to 70 million years ago. From 80 to about 60 million years ago, erosion stripped off the roof of the Batholith, causing it to rise in the crust. By at least 52 million years ago the granite of the Idaho Batholith, rock that had crystallized 8 to 10 miles deep, was exposed at the surface. (Moye, in preparation). The Batholith contains varying amounts of quartz, orthoclase, plagioclase, and biotite. Granite is rock composed of quartz, sodium-rich plagioclase, biotite, hornblende, and potassium feldspar. It is a common igneous rock, formed by the slow cooling of magma below Earth's surface. Our discussion focuses on the Atlanta Lobe of the Batholith that underlies the western portion of the Salmon River Basin drainage, specifically the lower to middle Salmon River. The western margin is strongly folded and metamorphosed into gneissic rocks that are well exposed near the town of McCall, ID.

Overall, the western side of the Batholith is composed of quartz diorite, whereas the eastern side ranges from granodiorite to granite. These differences are due to the rock's genesis; the western rocks formed from oceanic rocks near the subduction zone, and the eastern rocks from the melting of the Belt Supergroup (Hyndman 1985). The core of the Batholith is biotite granodiorite, which will fit into the plutonic-granitic category.

The Basin Creek drainage, in the upper Salmon River Basin near the town of Stanley, is an example of batholith rocks (Basin, Little Basin, and Sunday Creeks). Most of the streams in the Payette National Forest flow through the Idaho Batholith including, Chamberlain, Lodgepole, West Fork of Chamberlain, Lick and its tributaries, Rush, Caton, Monumental, Tamarack, McCalla, and the Whimstick Creeks. These are plutonic and granitic.

Other large plutons such as the Bighorn Crags, Sawtooth Mountains, and the Casto Batholith (all Tertiary) are aligned along a northeast-trending belt in the east-central part of the Idaho Batholith. Some plutons even cut Challis

volcanic rocks. These intrusions have a well-developed vertical jointing that creates distinctive ragged topography (Maley 1987). It suffices to call these areas plutonic and granitic.

The Sawtooth Mountains are underlain by rocks of the granitic Idaho Batholith and the younger Sawtooth Batholith. The Sawtooth Batholith is a distinctive pink granite that contrasts sharply with the gray granitic rocks of the Idaho Batholith. The color is caused by the presence of perthitic orthoclase. The Sawtooth Range is a high, uplifted fault block, or horst. It is bounded on the east by the Stanley Basin, a down-dropped block or graben, and on the west by the Montezuma Fault. The Sawtooth Range comprises a spectacular variety of features produced by alpine glaciation.

The Stanley Basin is covered by a thin veneer of alluvium. Glacial deposits consist of unsorted clay, sand, cobbles, and boulders left by melting glaciers. The alluvium of most of the Sawtooth area watersheds is derived from the Batholith and, therefore, is granitic-plutonic (Maley 1987). Streams within the basin include Goat, Knapp, Marsh, Cape Horn, Beaver, Banner, Fishhook, Alpine, and Hell Roaring Creeks.

The Bighorn Crags Batholith is a granitic intrusion in the center of Challis volcanics. Wilson and Clear Creeks are examples in this type of geology. Gant Ridge separates the Crags Batholith from the Panther Creek Drainage, which has a metasedimentary geology.

The Casto Pluton is composed of two rock types: (1) a pink granite rich in potassium feldspar and (2) gray quartz monozite (Johannsen 1948). Loon Creek, mid-reaches to headwaters, is in this granitic geology. Rapid River, upper Middle Fork of the Salmon River, drains from the Casto Batholith along with its tributaries, Float and Vanity Creeks; yet its mouth and lower 7 miles reside in Challis volcanic flows.

The soils derived from granitic parent materials are generally sandy loams to stony-loamy sands at the surface, and sandy loams to gravelly loams and gravelly-clay loams in the subsurface. Most of the Idaho Batholith contains shallow, coarse-textured soils that are highly susceptible to erosion when disturbed (Payette National Forest 1992).

Challis Volcanics

The Challis volcanics are a thick series of volcanic flows and tuffs that cover about 1,900 square miles in east-central Idaho. Dacite and andesite are dominant in the flows, while basaltic and rhyolitic lavas erupted to a lesser extent. Rhyolitic lava (Twin Peaks eruption), domes, and ash-flow tuffs erupted from caldera complexes. Among these rhyolitic flows and tuffs are ancient lake bed sediments. The volcanism started around 51 million years ago from a variety of widely spaced vents and continued until about 40 million years ago. The resulting volcanic deposits once covered nearly half the state of Idaho.

The East Fork of Mayfield Creek in the Loon Creek Drainage, 5 miles west of the Twin Peaks Caldera, contains many ash-flows. The Twin Peaks Caldera is a roughly circular collapse structure, 12.5 miles in diameter, that formed about 45 million years ago. The Challis geologic map shows the East Fork of Mayfield Drainage developed in a rhyolitic flow, though the narrow stream channel is undivided alluvium. Warm Spring Creek, another tributary to Loon Creek, resides on rhyolitic tuffs as well. These are unusual geologies, and the streams must be compared to streams in similar ash-tuff parent material.

Lower mainstem Loon Creek lies mostly on the Idaho Batholith. The middle reaches are in the Casto Pluton, which is also granitic; however, the upper 10 to 15 miles are in the Van Horn Peaks Caldera that is rhyolitic tuff. Because it is such a long stream with a large drainage, it is broken into reaches to reflect its different rock types. Van Horn Peaks and Thunder Mountain Caldera complexes contribute more rhyolitic tuff to Marble, Trail, Dynamite, and Big Cottonwood Creeks.

Indian Creek is another composite. Its tributaries, Big Chief and Little Indian Creeks, are in biotite granodiorite and granite. Indian Creek is in a dacite and diorite complex. This sequence is exposed in, and adjacent to, the Van Horn Peak caldron complex, consisting of both intrusive and extrusive rock (Fisher and others 1983). Although it is near the Challis volcanics, the dominant geology is a diorite pluton.

Other Geologies

The White Cloud Mountains, east of Stanley Basin, appear white from the exposed limestone and other sedimentary rocks. Champion Creek and its South Fork lie in a watershed of granitic alluvium and fine-grained carbonaceous argillite and silty limestone. Rhyolite flows are present to a lesser degree, thus its dominant geology is sedimentary and fine-textured. Germania Creek, located on the east side of the White Cloud Mountains, drains both volcanic basalt and sedimentary limestone.

Metamorphosed sedimentary rocks of micaceous quartzite and schists in the Salmon River Mountains west of Shoup are intruded by gneiss (Maley 1987), which weathers much like granite. Woodtick Creek, Clear Creek, and Trail Creek also drain areas of metamorphic rock type. These rocks are Precambrian, around 1.5 billion years old. This gneiss may be examined just east of Shoup along the Salmon River (Maley 1987). Hayden, East Fork Hayden, and Bear Valley Creeks, are metamorphic drainages containing quartzite rock.

Discussion

We reasonably assume that similar rocks will react to stresses in a similar way. It should be apparent that some rocks are chemically more stable than others and thus are not altered as rapidly by chemical processes. For example, the metamorphic rock quartzite, composed of quartz, is an extremely stable substance that alters slowly compared to most rock types. In contrast, rocks such as granite, which contain large amounts of feldspar minerals, decompose rapidly because feldspars are chemically less stable. Feldspar forms deep in the earth at a higher temperature than quartz. Weathering is both a chemical and mechanical process. The stress release when granite gets to the earth's surface weakens the grain boundaries, and erosion follows.

Volcanic rhyolites have the same composition as granites but are aphanitic or fine-grained. A fine-grained mineral will not weather as quickly as a coarse-grained one, being less porous. Rhyolitic lava flows are thick and highly viscous and move only short distances. Rhyolitic tuff is light-colored, silica-rich, consolidated ash. The volcanic basalt drainages erode quicker than the granitic or quartzitic areas. Basalt is an aphanitic (fine-grained) rock composed of relatively unstable calcium-rich plagioclase and pyroxene, which cools slowly at high temperatures (approximately 1,000 °C).

Ferromagnesium minerals, found in basalts, andesites, and diorites, are chemically unstable and, when chemically weathered, yield clays, iron oxides, and ions in solution. The minerals that crystallize at a lower temperature (quartz, mica) are chemically stable, whereas those that form early (plagioclase and feldspar) are easily altered by chemical processes because they are most out of equilibrium with their conditions of formation (Monroe and Wicander 1992). Weathering of rock, grain size, amount of moisture, and vegetation play an important role in finding which soils form and how a stream will develop and behave.

The Idaho Batholith dominates the portion of the Frank Church Wilderness administered by the Payette and Boise National Forests, whereas Challis volcanics dominate exposures in the Challis National Forest and southern part of the Salmon National Forest. These forests can make good areas for comparative studies from similar stream drainages based upon geology.

Appendix C: Natural Condition Data Base

The natural condition data base is currently stored electronically in dBaseIV. It contains stream channels within the Salmon River Basin, ID, that represent the natural state (structure and pattern) of streams only influenced by natural disturbances. Using these data, frequency distributions (relative and cumulative frequencies) were graphed to display the range and distribution of natural variability for percent bank stability, percent bank undercut, water temperature, width-to-depth ratio, width-to-max depth ratio, and percent surface fines. The following steps were used to create these frequency distributions.

In dBaseIV, the data file was queried to filter out the following fields: STREAM, SURVEY REACH, SURVEY YEAR, FOREST, GEOLOGY, REACH TYPE, CLASS, CHANNEL CODE, DRAINAGE AREA, HABITAT TYPE, HABITAT GROUP, HABITAT CLASS, HABITAT LENGTH, and the desired habitat variable listed above. Filter conditions were entered in some fields to control the resulting data. For example, in cases of missing data, negative 99's (–99) are shown in the data base; therefore, the filter condition greater than or equal to zero (≥0) was entered into the space beneath the field name of the appropriate habitat variable. Other conditions entered at times included "GRANITIC" under GEOLOGY; "A", "B", or "C" under REACH TYPE; "M" (main) under CHANNEL CODE, and so forth. Each query was saved as a separate data base file and opened in QuattroPro.

In QuattroPro, frequency distributions were created in the following way. The column containing the habitat variable data was copied and sorted. A bin was set up as a single column showing the intervals to be analyzed using the Block | Fill command. For example, if the sorted column containing percent surface fines was column G (G2..G1040), the bin block would be column H (H2..H1040). The starting number would be 0, steps would be 10, and the stopping number would be 100. Using the Data | Frequency command, the results are obtained. The value block would be G2..G1040, the bin block would be H2..H12, and the results would now be shown in column I (I2..I13). To calculate relative frequencies, the observed frequencies (column I) were converted into percentages based on the total number of observations. Column I was first summed, then each frequency in column I was divided by the total number of observations (sum of column I) and multiplied by 100, the results displayed in column J. A graph was then created, column H as the X-axis and column J as the first series.

Overton, C. Kerry; McIntyre, John D.; Armstrong, Robyn; Whitwell, Shari L.; Duncan, Kelly A. 1995. User's guide to fish habitat: descriptions that represent natural conditions in the Salmon River Basin, Idaho. Gen. Tech. Rep. INT-GTR-322. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 142 p.

This user's guide and reference document describes the physical features of the Salmon River Basin, Idaho, stream channels that represent "natural conditions" for fish habitat—that is, streams that have not been influenced by major human disturbances. The data base was created to assist biologists and resource managers. It describes resource conditions that can be achieved through management objectives.

Keywords: desired future conditions, habitat variables, multiscale analysis, channel features

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